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BEFORE THE PUBLIC UTILITIES COMMISSION OF THE

STATE OF CALIFORNIA

Order Instituting Rulemaking to Consider Strategies and Guidance for Climate Change Adaptation.	Rulemaking 18-04-019

SOUTHERN CALIFORNIA EDISON COMPANY'S (U 338-E) COMMENTS ON ADMINISTRATIVE LAW JUDGE'S RULING REGARDING JUNE 24, 2019 WORKING GROUP TOPIC 4 REPORT

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BEFORE THE PUBLIC UTILITIES COMMISSION OF THE

STATE OF CALIFORNIA

Order Instituting Rulemaking to Consider Strategies and Guidance for Climate Change Adaptation.	Rulemaking 18-04-019

SOUTHERN CALIFORNIA EDISON COMPANY'S (U 338-E) COMMENTS ON ADMINISTRATIVE LAW JUDGE'S RULING REGARDING JUNE 24, 2019 WORKING GROUP TOPIC 4 REPORT

Pursuant to the California Public Utilities Commission's ("Commission" or "CPUC") Ruling issued on June 25, 2019, regarding June 24, 2019 Working Group Topic 4 Report, in the Order Instituting Rulemaking (OIR) to Consider Strategies and Guidance for Climate Change Adaptation , R.18-04-019, Southern California Edison Company ("SCE") respectfully submits the following comments, in addition to the separately-filed joint utility comments that Pacific Gas & Electric Company (PG&E) is filing on SCE's behalf.

I.

INTRODUCTION

SCE agrees that it is important to understand community vulnerabilities as it relates to climate change impacts and supports the staff's proposal that the community vulnerability assessment should build on assessments of the utilities' climate vulnerability. However, SCE urges the Commission to reconsider the timing required to complete the assessments. The staff proposal's suggestion to complete a thorough community vulnerability assessment with input gathered from community stakeholders, within 12 months of a Commission decision, fails to consider the time needed by the utilities to complete the asset vulnerability assessment (Steps 1-3 as outlined in the staff proposal) that precedes the community vulnerability assessment. Before undertaking this analysis, utilities could greatly benefit from additional clarification and agreement on both the desired level of granularity sought from a utility asset vulnerability assessment and the goal of the assessment (e.g., to produce future studies or to justify certain costs). Assuming that the climate data is at a resolution and a level of certainty that is useful for system impact evaluation, and without knowledge of the exact scope of the analysis, SCE estimates that it may be able to complete a focused analysis of specific climate risks—such as the potential increase in number of curtailments due to Public Safety Power Shutoff-type efforts—within 12 to 24 months of a Commission Decision. SCE's preliminary estimates also suggest that it may take 3 to 5 years to complete a comprehensive asset vulnerability analysis.

The sequence of the vulnerability assessments is important for all stakeholders involved. Utilities need to identify which communities will be affected by climate change impacts to the grid, in order to facilitate appropriate community engagement that ascribes to the principle to "strengthen skills, knowledge, relationships, and power of communities to participate in decision-making processes related to climate adaptation."[1] Accordingly, the timeline for completing the full community vulnerability assessment (Steps 1 to 6) should include the 12 to 24 months needed for utilities to at least complete a focused asset vulnerability assessment. SCE respectfully asks the Commission to revisit the timeline in this proceeding for completing the community vulnerability assessment before issuing a Proposed Decision.

Finally, convening and organizing the stakeholders to contribute to community-scale adaptation planning processes should be led by the localities, the Commission, or both in partnership, in coordination with the Governor's Office of Planning and Research's Integrated Climate Adaptation and Resiliency Program efforts. Water, transportation, and other key

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[1] Order Instituting Rulemaking (OIR) to Consider Strategies and Guidance for Climate Change Adaptation (R. 18-04-019) Working Group Session Report on Item "Climate Vulnerable and Disadvantaged Communities," Attachment 1, p. 26.

infrastructure stakeholders should participate in the community engagement process, as these systems are inextricably linked with energy service.

II.

CONTRARY TO THE ASSUMPTIONS IN THE STAFF PROPOSAL, SCE HAS NOT COMPLETED STEPS 1-3 FOR THE DEPARTMENT OF ENERGY REPORT

The staff proposal assumes that utilities have already performed detailed simulation and analysis as part of the Department of Energy climate vulnerability reports ("DOE reports") and yet this report was intended as a starting point for discussion on how a climate change impact analysis could be performed throughout the electric system. The description in the staff proposal, that the three investor-owned utilities (IOUs) in their DOE Reports have "determined how and when climate impacts (e.g. sea level rise, temperature, precipitation) may affect utility assets,"[2] does not accurately depict the intent and outcome of SCE's 2016 DOE report (*See* Attachment A, which includes both "SCE Climate Impact Analysis and Resilience Planning" and "Progress Update." Together these are "SCE's 2016 DOE report").

The SCE 2016 DOE report attempted to research potential climate hazards—provided in existing literature—that will impact certain geographic regions within SCE's service territory and could impact electric utility equipment. The report produced examples of how to potentially forecast climate impacts throughout the system, but did not identify actual asset locations on SCE's system where climate hazards may cause equipment failure. For example, SCE developed the Adaptation Planning Tool, which forecasted potential climate hazards in a specific region but did not predict how the equipment will react to those climate impacts. There is a fundamental difference between understanding what future temperature may look like in a specific geographical location and how increased temperature will affect utility assets in that geographical region. The latter will require research teams to perform detailed simulations.

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[2] *Id.* p. 28.

Nevertheless, SCE has continued to work on assessing the risks and possible mitigations for climate change. For example, in its 2018 Risk Assessment Mitigation Phase Report (RAMP)[3] , SCE refined its initial analysis and prepared mitigation plans to address near-term climate change impacts. In addition, SCE described its approach and early findings from its medium- and long-term climate change vulnerability and impact assessment. Finally, SCE's RAMP report acknowledges that a more comprehensive assessment is still required and welcomes engagement with stakeholders to create strategies to address the current and future impacts of climate change. Similarly, in this Climate Adaptation proceeding, SCE strongly agrees with the Commission on the need to develop an asset climate vulnerability assessment. SCE is taking proactive steps to analyze these risks, but it has a sizeable amount of work ahead to achieve Steps 1-3 in the staff proposal.

SCE suggests increasing collaboration between the Commission and the utilities to understand the level of granularity required to achieve the goal in the staff proposal. Step 1 states that, as part of the 2016 DOE report, utilities have "...determine[d] the total number of known assets in the IOU's service territory."[4] However, the 2016 DOE report did not identify a "total number of known assets in the IOU's service territory." The higher the total number of assets to be analyzed, the more time and work it will take to achieve these goals. Importantly, this effort will likely require increasing both SCE staff levels and the level of coordination with research groups to assist with the technical probabilistic simulations and risk analysis needed to assess climate impacts on electric utility equipment.

Similarly, SCE needs and has previously asked for guidance from the Commission on which climate risks to assess.[5] This step is necessary for utilities to complete Step 2, which directs utilities to "[i]dentify current and future climate risks as related to those assets."[6] Without

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3 SCE's 2018 Risk Assessment and Mitigation Phase Report (RAMP), Chapter 12, "Climate Change".

4 OIR, Attachment 1, p. 28.

5 *See* Southern California Edison Company's (U 338-E) Comments on Administrative Law Judge's Ruling Regarding March 15, 2019 Working Group 2 Report.

6 OIR, Attachment 1, p. 28.

clear direction from the Commission on the models and data sets to use, utilities may arrive at different determinations of asset vulnerabilities due to different approaches to the data. Flexibility is also needed as utilities face different climate risks based on the geographical location of assets and may be required to consider different climate change-related threats.

The staff proposal directs IOUs in Step 3 to determine "the sensitivity of those assets to climate impacts,"[7] but SCE will need time to determine which areas of the system are unable to serve customers based on current operating limits and how climate hazards are impacting equipment ratings. SCE must develop detailed electric system modeling to be able to run simulations to understand potential failure points on the system caused by climate change threats. SCE has not yet begun this level of analysis. SCE initially estimates that it may take 12 to 24 months to complete a selective analysis of specific climate risks. SCE's preliminary estimates also suggest, however, that it may take from 3 to 5 years to complete a rigorous engineering analysis of the entire utility system's vulnerability to climate change impacts to assess the risk of equipment failure. This effort will likely require an increase in utility staff to support the analysis. The 3 to 5-year estimate also assumes that climate exposure scenarios are: a) already at a resolution level that is useful for system impact evaluation to determine precise equipment problems, and b) at a point where each scenario can be assigned a risk probability. SCE can determine with greater certainty the amount of time required to achieve Steps 1 through 3 only after the Commission and parties clarify the level of detail desired from this analysis.

III.

THE COMMISSION SHOULD CLARIFY THE GOALS AND APPROACH TO COMMUNITY ENGAGEMENT

Before utilities begin Steps 4-6, the Commission should articulate the intent of the community engagement. If the goal of the community vulnerability assessment (Steps 1 to 6) is

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[7] OIR, Attachment 1, p. 28.

to "...understand the risks as they relate specifically to vulnerable and disadvantaged communities in [the utilities'] territories,"[8] then there are two options for using the information that comes from this type of assessment: 1) adjustment in the utility's adaptation plan, and/or 2) adjustment in the affected vulnerable and disadvantaged communities' adaptation plans.

In the first option, utilities can take the information and adjust plans for the utilities' adaptation. For instance, a community vulnerability assessment may produce information about a specific geographic area that should be made more resilient, due to the anticipated impacts to the climate vulnerable or disadvantaged community. Utilities can use this information to prioritize creating engineering solutions as part of the utilities' adaptation plan that will help lower the risk of disruption to electrical (or gas) service to communities for that area. The utility's climate adaptation plan will likely focus on modifications to its infrastructure and operations. SCE notes, however, that it is unclear what community input the Commission is expecting in such a technical process driven by engineering analysis and solutions.

In the second option, the information from the community vulnerability assessment would inform the development of the vulnerable and disadvantaged communities' adaptation plan. In this case, the utilities are only providing one input, but many sectors would need to come together for integrated community adaptation planning. The localities, the Commission, or both in partnership, should lead the convening and organizing of stakeholders to contribute to community-scale adaptation planning processes. They should also coordinate closely with the Governor's Office of Planning and Research's Integrated Climate Adaptation and Resiliency Program efforts and with multiple sectors, including electric, water, transportation, and other key infrastructure sectors to develop a holistic approach to communities' adaptation planning.

Although these two options are not mutually exclusive, the Commission should delineate between the type of community input sought for feedback on a utility's climate adaptation plan and for a vulnerable or disadvantaged community's climate adaptation plan.

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[8] *Id.* p. 27.

IV.

ADDED CONSIDERATIONS FOR THE COMMUNITY VULNERABILITY ASSESSMENT TO BETTER SUPPORT COMMUNITIES' ADAPTATION

To participate in an effective community engagement process with the relevant vulnerable and disadvantaged communities facing risk of curtailed utility service due to climate change, SCE needs to first perform an asset vulnerability assessment to identify which communities may be affected. Conducting the asset vulnerability assessment before the community vulnerability assessment will help address concerns expressed by Small Business Utility Advocates and others during the working group discussions about the "actionable information" that utilities could provide during community engagement about the climate impacts to the system.[9] If a goal of the community vulnerability assessment is to support communities' climate adaptation plans, then SCE recommends that utilities assess community vulnerabilities (Steps 4-6) before beginning any in-depth engagement with the identified vulnerable communities, with these considerations in mind:

- Steps 4 through 6 should aim to improve the utility's understanding of the vulnerabilities and adaptive capacities of the climate-vulnerable and disadvantaged communities related to the loss of utility service.
- Step 4 should be predicated on the emergence of a clear definition of climate-vulnerable and disadvantaged communities from the OIR Decision. There should also be clear guidance from the OIR on the tools that utilities can use (e.g., CalEnviroScreen 3.0, Climate Change and Health Vulnerability Indicators for California, Healthy Places Index, and Regional Opportunity Index) to identify and understand initial vulnerabilities and adaptive capacities associated with these communities related to climate change.
- Steps 5 and 6 should begin an iterative process. SCE proposes gathering an initial understanding of the communities' climate vulnerability and adaptive capacity (via the

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[9] *Id.,* pp. 8-9.

tools noted for Step 4 and potentially other methods), before initiating formal engagement with these communities. This understanding can then be refined after directly hearing from the communities.

- As part of Steps 5 and 6, utilities should be able to consult expert stakeholders such as the CPUC's Disadvantaged Communities Advisory Group and other experts from organizations engaged in climate change adaptation research and policy. These expert stakeholders understand both the power system and the needs of vulnerable and disadvantaged communities, and, therefore, can help refine the understanding of the consequences for these communities of utility service curtailment due to climate change.

Once Steps 4 to 6 are completed, utilities can approach the relevant communities with information about the risk of curtailed utility service due to climate change. The affected vulnerable and disadvantaged communities can then use the information to identify and weigh the options available to them for mitigating these risks. It is prudent for this deliberation to be locally-driven and involve the State, local governments, community-based organizations, and other sectors, so that the interdependencies among the different sectors can be considered.

V.

CONCLUSION

SCE looks forward to partnering with the Commission, local jurisdictions, and community stakeholders to better identify and prioritize the needs of vulnerable and disadvantaged communities in climate adaptation within its service territory. SCE thanks the Commission for its consideration of SCE's comments on the Working Group 4 Report.

Respectfully submitted,

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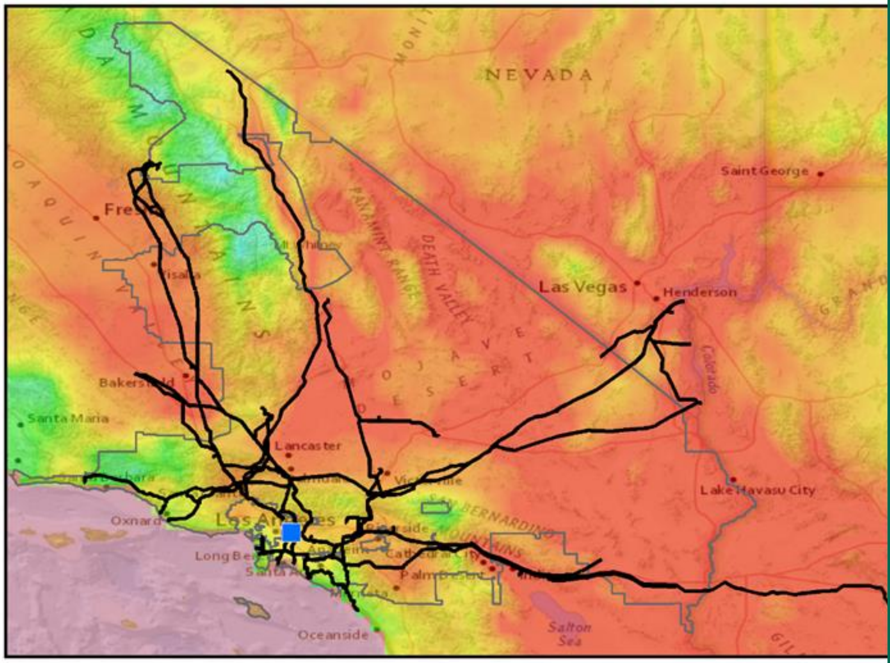
July 12, 2019

Attachment A

SCE's 2016 DOE report

2016

Southern California Edison Climate Impact Analysis and Resilience Planning



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1 EXECUTIVE SUMMARY

In 2015, SCE became one of 17 utilities voluntarily participating in a U.S Department of Energy (DOE) project, Partnership for Energy Sector Climate Resilience, aimed at enhancing energy security by improving the resilience of energy infrastructure against the impacts of extreme weather and climate change. The goal was to understand how the wider trends of climate change on a global scale would translate into local changes in energy system performance.

Building upon research done by the California Energy Commission (CEC) and the scientific community, SCE created an Adaptation Planning Tool, which allowed SCE to analyze the impacts that long-term climate change would have throughout its service territory, down to the local level. In early 2016, the findings of this research were submitted in a report to the DOE and the California Public Utilities Commission (CPUC). This report detailed the impacts that SCE would likely to experience over the next 100 years as a result of global climate change in southern California. Key vulnerabilities impacting SCE over the next 100 years include:

- Increased risk for facility inundation and flooding, especially at 18 at-risk coastal facilities
- Transmission, distribution, and generation systems will operate less efficiently under extreme heat
- Increased demand due to ongoing increased average temperature and extreme heat days
- Disruption of service due to facility and equipment loss following flood and landslide events
- Limited generation capacity due to decreased reservoir levels
- Disruption of service due to facility and equipment loss due to wildfire events
- Employee and public safety and wellbeing impacted by wildfire events
- Increased liability due to higher potential of utility caused fires

Throughout the summer of 2016, SCE held a series of workshops, in which subject matter experts were brought together to identify solutions to the impacts long-term climate change will have on the SCE network. From these workshops numerous mitigation measures were identified and shared throughout the company and will serve as the basis for continued development of a climate change resilience action plan. Summarizing the findings of these workshops, key mitigation efforts would include:

- Design new facilities and equipment utilizing future modeling instead of historical data
- Initiate facility relocation well in advance of coastal inundation at at-risk facilities
- Implement engineering solutions to mitigate facilities at increased risk for inundation, flooding, mudslides, and debris flows
- Install additional equipment to decrease burden on existing equipment
- Increase the use of distributed energy solutions to limit the burden on the transmission system
- Increase the capacity of the existing reservoir system through additional locations and a more robust catchment system
- Mandate all new facilities in at-risk location for wildfires have 2 independent evacuation routes

Work will continue throughout 2017 and 2018 to further refine these proposals to determine the most viable and realistic solutions that will best serve SCE's communities.

The climate is changing, and will continue to change. SCE is committed to working with the DOE, CPUC, and the communities we serve to ensure that together we are prepared for that future. Over the next 3 years, SCE will work closely with subject matter experts to develop an effective resilience action against long-term climate change for implementation into the 2020 general rate case.

2 RESILIENCE PLANNING SCOPE

2.1 RESILIENCE PLANNING GOALS

SCE is a major business and significant contributor to the Southern California economy. SCE's resilience plan goal is to identify strategies that can meet California's regional climate adaptation needs while continuing to ensure that electricity is safe, reliable, and affordable.

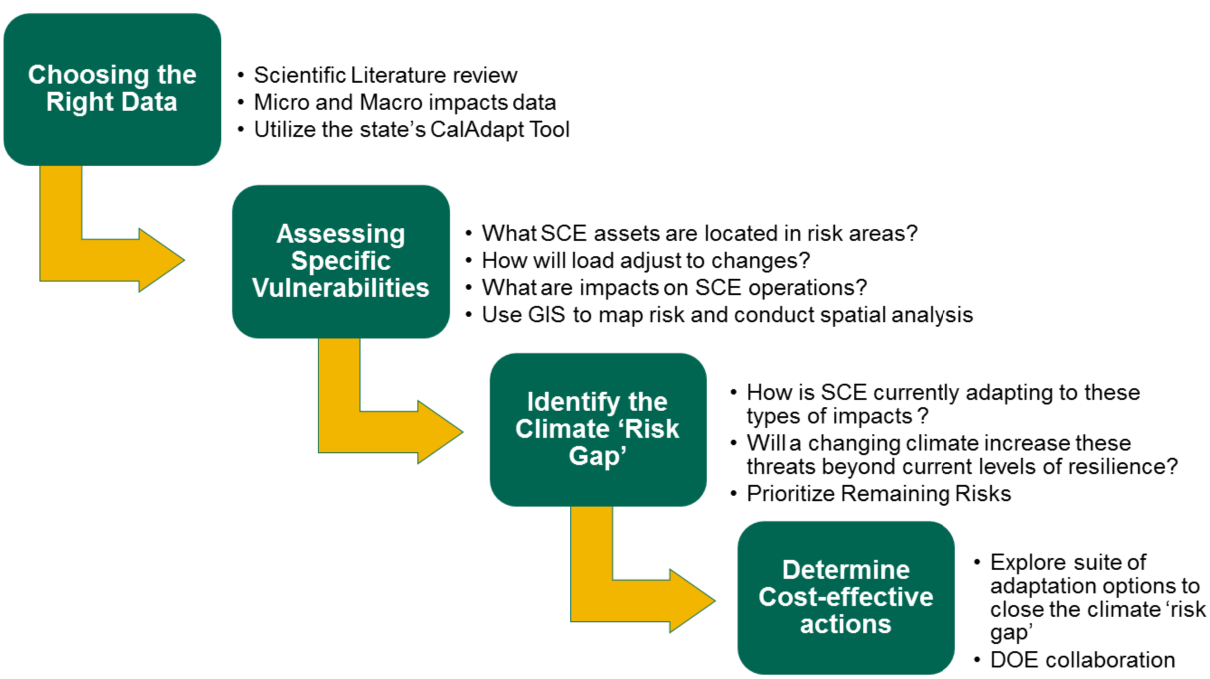
With this goal in mind, SCE joined the DOE's Partnership for Energy Sector Climate Resilience on July 22, 2014. As a Partner, SCE agreed to "identify priority vulnerabilities to energy infrastructure assets and operations from extreme weather and climate change impacts" and to work with the partnership and stakeholders to determine a resilience plan.

2.2 ADAPTATION PLANNING FRAMEWORK

SCE, in conjunction with external stakeholders, created an adaptation-planning framework that functions as its DOE Partnership work plan. Key to this framework is four milestones: Choosing the Right Data, Assessing Specific Vulnerabilities, Identifying the Climate 'Risk Gap', and Determining Cost–effective Actions to address any remaining risks.

In the flow chart below, SCE has highlighted key questions to be answered, and actions to be taken, in order to achieve each milestone. Along with the DOE Partners, SCE has completed the first phase of the DOE partnership represented by the first two milestones and we will be focusing on the final two milestones in the months ahead. At this point SCE has an understanding of the potential impacts, and is now considering where risk mitigation is necessary, and which actions are appropriate to provide reliable, safe, and affordable electric service to our customers.

Figure 1: Four milestones of the adaptation-planning framework



3 Climate Change Analysis

Southern California Edison (SCE) utilized the data from the Cal-Adapt climate change research program as the basis for its long-term impact and vulnerability assessment. The impacts outlined in the Cal-Adapt study were further reviewed and categorized into broad vulnerability categories to allow for the development of more effective mitigation strategies as outlined in Section 3.3 of this document.

3.1 Develop Inputs On Climate Change

Identify Climate Change Projections

Attempting to understand how global climate change will affect local communities, researchers have refined methods of modeling global climate change in order to apply those projections to local regions and communities. This progress is allowing climate scientists, state regulators, and now utilities, to speak with added confidence about the impacts Southern California could face in the decades ahead. The trend is clear, more warming can be expected, and with that warming, comes additional variability across a number of weather and natural phenomena.

SCE's internal analysis, and the scientific literature reviewed, both draw from many of the same down-scaled models utilized in research funded by the California Energy Commission (e.g., Westerling and Bryant 2008; Westerling et al. 2009; Cayan et al. 2009; Heberger et al. 2009).

The projections made in this climate impact analysis stem from an emission scenario (called 'A2') created by the Intergovernmental Panel on Climate Change (IPCC). The A2 scenario is considered to represent a medium-high emissions scenario. This scenario describes a world with a large income disparity, slow technological diffusion, and high greenhouse gas emissions. In the A2 scenario, global carbon dioxide ($CO2$) emissions reach nearly 30 gigatons of carbon (GtC) annually by 2100. SCE utilized this emissions scenario to conduct an internal spatial analysis because SCE is interested in exploring the extent of the climate risk gap (between current preparedness and the extremes of climate change) and also because when viewing the data it appeared more optimistic emission scenarios track relatively near the A2 scenario in the near-term (out to 2030). SCE views this vulnerability analysis as an iterative process, and as more accurate global emissions projections are developed in the future, the tool SCE created can augment its assumptions by using different data sets.

Existing studies were consulted to verify analysis and draw further systemic conclusions. Two studies in particular were drawn upon to cross check SCE's internal analysis. The first was the 'Climate Change in the Los Angeles Region' project run by UCLA. This project is a collection of ongoing studies that began in 2010 and has been funded jointly by the City and County of Los Angeles, the U.S. Department of Energy, and the U.S. National Science Foundation. Another study key to our analysis was 'Estimating Risk to California Energy Infrastructure from Projected Climate Change' funded through the California Energy Commission's Public Interest Energy Research (PIER) Program and authored by researchers at Lawrence Berkeley National Lab (LBNL) and UC Berkeley . When citing potential impacts from previous studies, SCE has also attempted to draw from those works the climate impacts derived from the A2 scenario (or explicitly flag the use of other scenarios) to ensure consistency.

The SCE Adaptation Planning tool was designed to utilize datasets from numerous sources, including the Cal-Adapt climate impact that illustrates climate data over time within SCE's service territory. By utilizing different geospatial analysis processes, this tool extracts detailed climate impact data at each asset location. The tool easily iterates over multiple locations to create a time series impact at each asset location and report impacts in a table, which allows SCE the ability to create an impact analysis by a specific assets as the impact changes into the future. Utilizing the locational aspects allows SCE to draw conclusions from climate projections across our system, as well as focus in on specific facilities and assets. The ability to conduct this type of analytic over SCE's diverse 50,000 square mile territory ensures that SCE will be have geographic specific analysis to inform the effectiveness of mitigation strategies identified in the second phase of this effort.

The SCE Adaption Planning tool was designed for the data sets provided through the State's Cap-Adapt research portal for this initial analysis, but SCE designed the tool to be flexible enough to accept new data when it becomes available, allowing for iterative adaptation planning as the research community refines methods and gathers additional data.

3.2 CLIMATE CHANGE HAZARDS

SCE's analysis focused on understanding the climate impacts projected to occur to the energy assets that customers most heavily rely upon, and which SCE controls. As mentioned in the overview of SCE's analysis above, this included utility–owned generation, transmission lines greater than 115 kV, all substations, and a high-level look at distribution system impacts.

While there is still significant uncertainty regarding the likelihood of specific downscaled impacts at specific locations, focusing SCE's analysis at the facility (or asset) level has provided insights into trends and specific concerns that require additional analysis. The data breakouts below offer a representative look at how facility-level data can be generated from SCE's Adaptation Planning tool. This facility-level data combined with a thorough review of the scientific literature and a deep understanding of the challenges facing the SCE system, has allowed SCE to prioritize the list of assets being studied and will allow SCE to understand where our system may be vulnerable at the state, regional and facility-level.

These facility-level outputs provide SCE with a large quantity of information that can be analyzed to help better understand climate change hazards. For instance, while the snowpack data for Big Creek Hydro Generation (found in Table 2 below) is only representative of impacts at a specific facility, not the total watershed, further analysis can reveal the total impacts to hydro production for the region. The same type of analysis can be applied to other areas of concern such as extreme heat days and sea level rise.

Example of Facility-level Analysis Outputs

Table 1: Mesa substation facility analysis

Mesa Substation	2030 (2020 for Fire Data)	2050	2085
Avg Air Temp (c) Aug	27	28.3	29.6
Fire Risk Multiplier	0	0	0
Max Air Temp (c) Aug	34.2	35.5	36.8
Min Air Temp (c) Jan	11.9	11.2	6.5
Net Surf Radi (watt per square meter)	25	25.6	28.9
Precipitation (mm per month)	0	35.4	74.2
Runoff (mm per month)	0	1.6	5.1
Snow Water Equiv (mm per month)	0	0	0

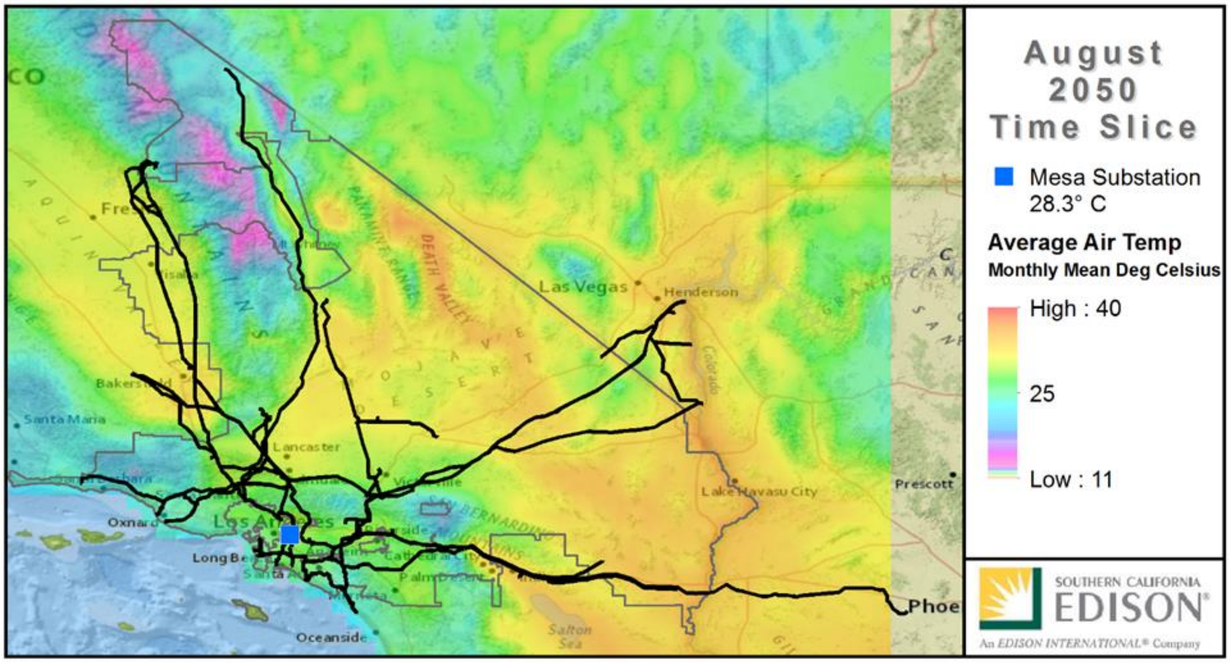
Table 2: Big Creek facility analysis

Big Creek #1- Hydro Generation	2030 (2020 for Fire Data)	2050	2085
Avg Air Temp (c) Aug	18.5	20.2	20.6
Fire Risk Multiplier	1	1.3	1.6
Max Air Temp (c) Aug	24.9	27.9	27.6
Min Air Temp (c) Jan	-0.3	-3.4	-4
Net Surf Radi (watt per square meter)	33.5	27.9	14.3
Precipitation (mm per month)	2	152.9	196.2
Runoff (mm per month)	0	23.6	20.4
Snow Water Equiv (mm per month)	0	68.3	52.3

The following section describes the climate impacts most likely to affect SCE's operations and assets. Drawing upon relevant previous studies and our own analysis, SCE presents below a summary of key findings and climate impact maps for the year 2050. Additional impact maps showing 2030, 2050, and 2085 snapshots side-by-side for reference are located in Appendix B, at end of this update.

1- Warming Temperatures:

According to research conducted by Cayan et al. (2009) mean temperatures in California are expected to warm significantly over the twenty-first century in all widely studied climate scenarios, especially in the summer and in inland areas. At a more regional scale, by mid-century, Hall et al. (2013) find the most likely warming under the business-as-usual scenario is roughly 4.6 degrees Fahrenheit averaged over the LA region's land areas, with a 95% confidence that the warming lies between 1.7 and 7.5 degrees. The high resolution of their projections reveals a pronounced spatial pattern in the warming: High elevations and inland areas separated from the coast by at least one mountain complex warm 20% to 50% more than the areas near the coast or within the Los Angeles basin (Hall 2013)**.** Moving beyond mid-century and urban centers, SCE's analysis finds the eastern border of the service territory may see average monthly ambient air temperature increases between 7 and 12 degrees Fahrenheit in the 2070-2099 period *resulting in decreased efficiency in SCE's current transmission, distribution, and generation systems*. The increase in average temperatures will also drive *an increase in customer demand* as electricity usage goes up during warmer weather. This region hosts five key transmission pathways serving load to southern California.



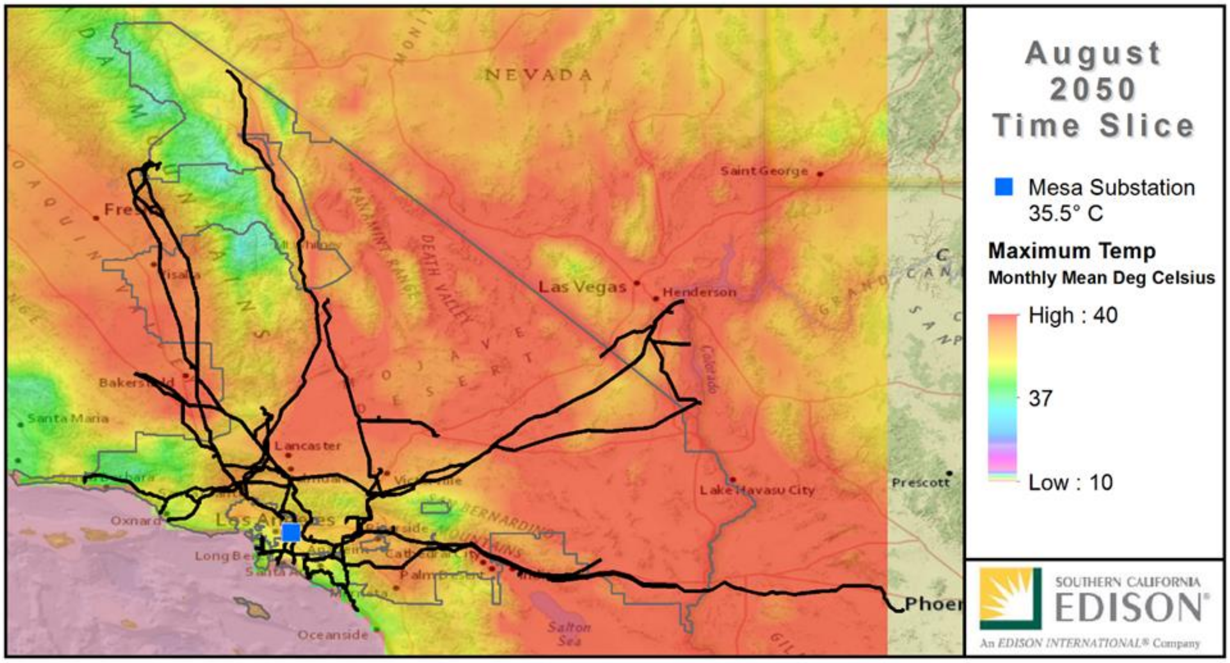
2- Extreme Heat Events:

According to research from Hall et al. (2013),

> "The number of extreme heat days, defined as days in which the high temperature exceeds 95 degrees Fahrenheit, rises everywhere at mid-century under the business-as-usual scenario. The number of extreme heat days in the future follows a similar spatial pattern to that of the warming results, with inland areas seeing much higher totals than coastal areas. For example, Santa Barbara sees average annual extreme heat days rise from 5 in the baseline period to more than 123 at mid-century under business-as-usual. By contrast, Riverside sees an increase from 58 days to 103 days."

Overall, this research finds a tripling of extreme heat days by mid-century in dense urban areas in Los Angeles County, the San Fernando Valley, and San Gabriel Valley.

Historically, most Southern California heat waves have occurred in July and August, but as climate warming occurs, these events appear to begin earlier in the season and could continue through the fall, while summer events become more frequent and more intense. The increasing tendency for multiple hot days in succession – resulting in heat waves that last longer – could cause problems for distribution infrastructure as well as transmission. Especially important may be the lack of nighttime cooling that has characterized recent heat waves in California, which can cause additional stress on the transformers that help serve customer load.



High temperatures can also result in decreased efficiency in generation. The LBNL (2012) study finds that higher temperatures will decrease the capacity of existing natural gas-fired power plants during extreme heat events. While they note that the estimated decrease in capacity varies (by region, emission scenario, climate model, and plant type) the trend is clear. During the hot periods of August at the end of the century, under the high emission scenario, the models used for this study estimate a decrease in natural gas power plant generating capacity of 3 percent to 6 percent in California. To put this phenomenon in perspective, total nameplate Capacity losses at California's gas-fired generating plants could total 10.3 GW on hot days by the end of the century (LBNL 2012). This should be compared with the 1961–1990 maximum coincident loss of 7.6 GW.(LBNL 2012)

The transmission of electricity will also be affected by increased ambient air temperature and extreme heat events. As described in the State of California's Third Climate Change:

> "In addition to reduced efficiency in the electricity generation process at natural gas plants, reduced hydropower generation, losses at substations, and increasing demand during the hottest periods (resulting in more than 17 Gigawatts or 38 percent of additional capacity needed by 2100 due to higher temperatures alone), transmission lines lose 7 percent to 8 percent of transmitting capacity in high temperatures while needing to transport greater loads."

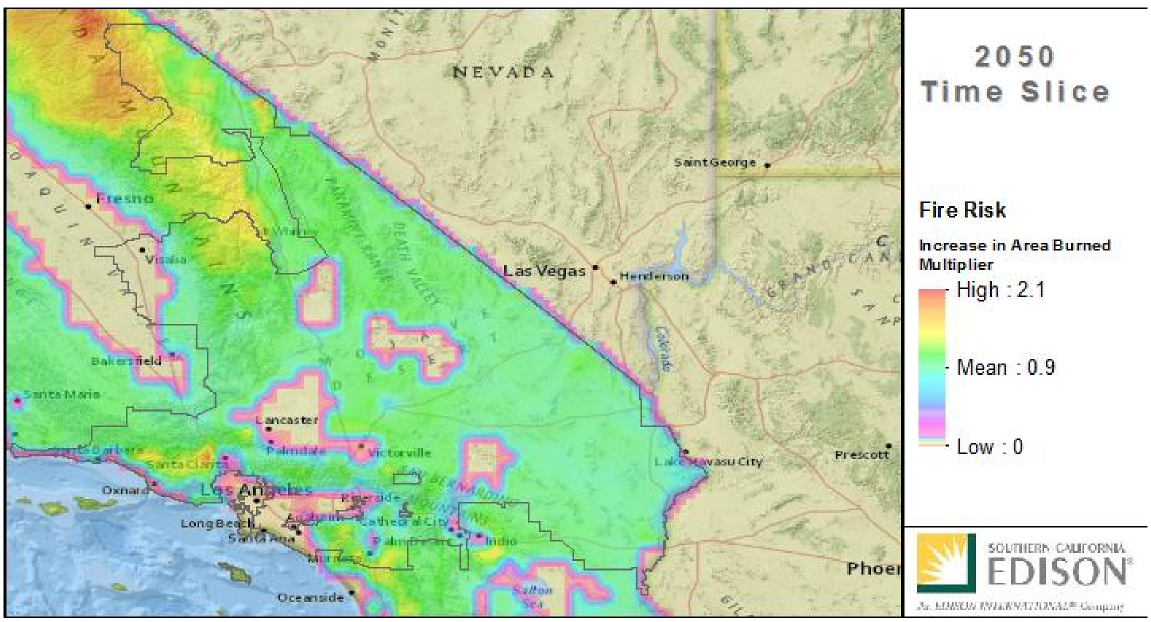
According to SCE analysis and previous studies, average annual air temperature is projected to rise between 7-12 degrees Fahrenheit along the eastern boundary of SCE's Service territory by the end of the century – subjecting at least 5 key transmission pathways to some of the most extreme warming our state will face. (SCE analysis, LBNL 2012) According to the LBNL study, a 9 degree Fahrenheit air temperature increase (the average increase predicted for hot days in August according to the Intergovernmental Panel on Climate Change's A2 scenario) diminishes the capacity of a fully loaded transmission line by an average of 7.5 percent. (LBNL 2012) This warming and increased chance of extreme heat will posing key risk due to the fact that Southern California draws on imports coming east for about one-third of its needs.

3- Increased Wildfire Risk:

Of the most damaging fires in the United States over the last 170 years, more than half occurred in California, and California leads the nation in economic losses from wildfire (Fried et al. 2004; Torn et al. 1998). Southern California wildfires can be a serious threat to electrical transmission and distribution lines, as they can result in increased maintenance costs and reduced line efficiency. As noted in the scientific literature, wildfire risk is influenced by a number of factors, including climate, topography, available fuel, and sources of ignition (Westerling et al. 2009). From studying the data, it seems that climate change will only exacerbate the problem, as increased temperatures, a reduced snowpack, and altered precipitation will lead to increased flammability of fuel for longer periods of time, which will affect the size, frequency, and severity of wildfires (LBNL 2012). The escalation in flammability *increases the liability for all electric utilities due to a higher potential for utility caused fires*.

One study summarized in California's Third Assessment finds, "a 40 percent increase in the probability of wildfire exposure for some major transmission lines, including the transmission line bringing hydropower from the Pacific Northwest into California during peak demand periods" (Third Assessment 2012). These fires will also *heighten the risk to crews working in remote locations with limited evacuation routes*.

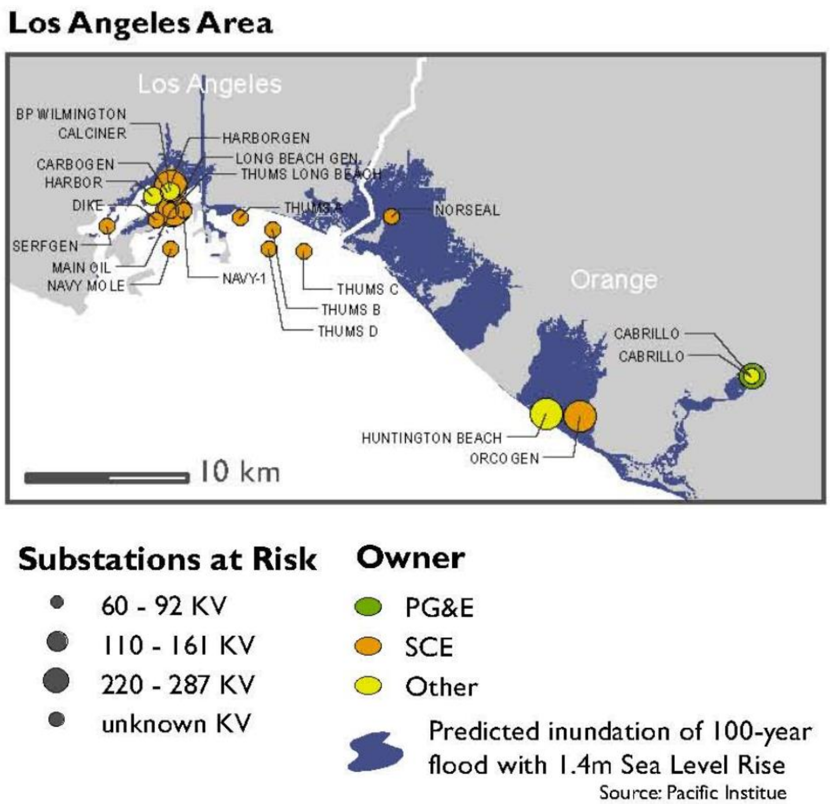
According to SCE's analysis of the data, this could mean *tripling of wildfire risk in extreme cases (ex. near transmission lines serving Santa Barbra)* but also slightly decreasing risk across the southeastern reaches of SCE's service territory (possibly due to vegetation migration) by the end of the century.



SCE currently utilizes CAL FIRE data, and on–the-ground inspections, to assess threats to SCE's system from wildfire. However, CAL FIRE's Fire and Resource Assessment Program Fire Threat Map hasn't included the explicit impacts of increased fire risk due to climate change. SCE will seek to integrate this climate change data into its planning process and risk maps.

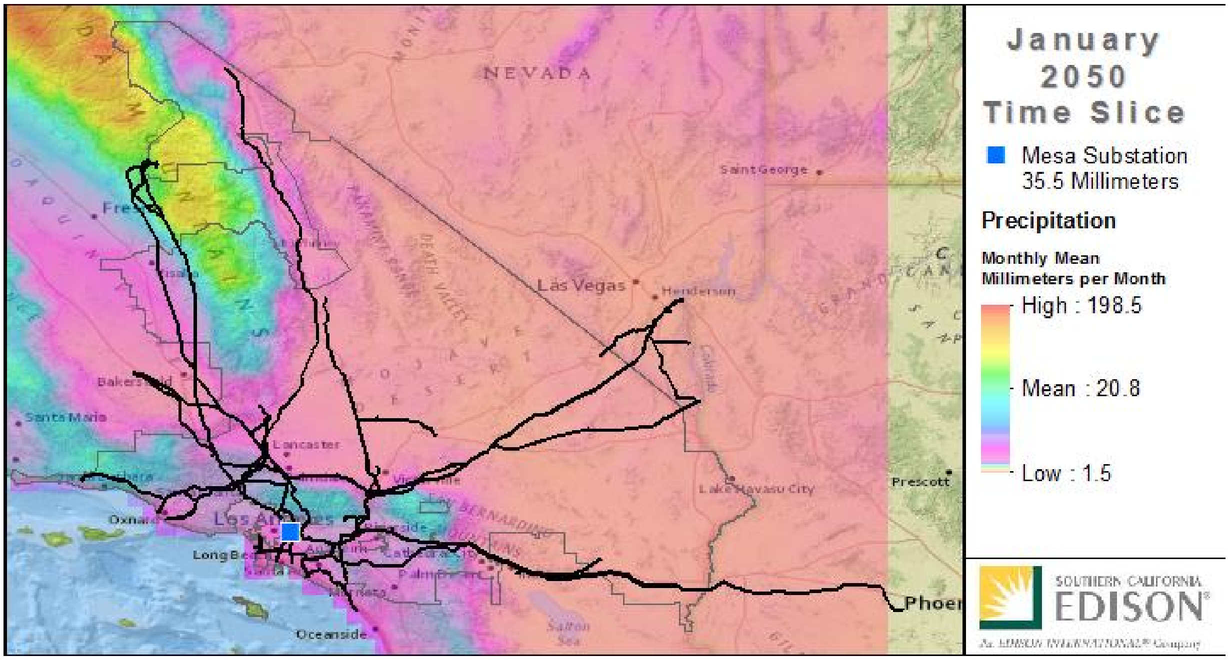
4- Sea Level Rise/ Coastal Inundation:

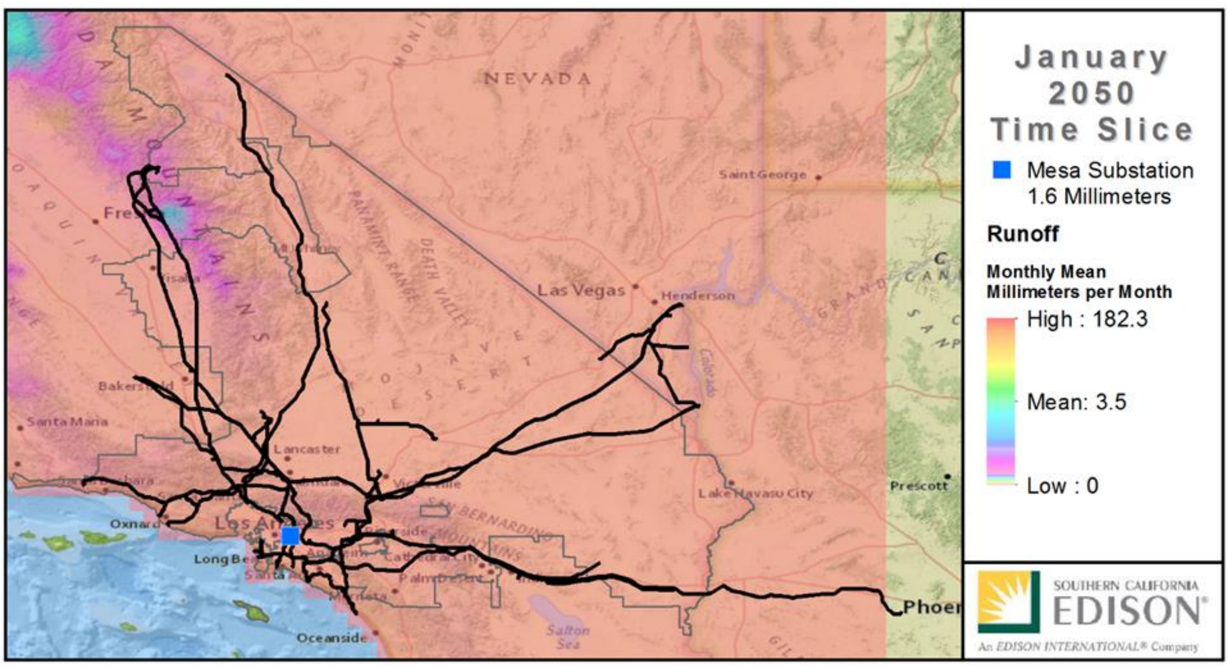
Sea level along California's coast has risen about 17–20 centimeters (cm) over the last century, and many studies anticipate a larger rise over the coming century (Cayan et al. 2009). Researcher studying the impacts of climate change (specifically the low (B1) to medium-high (A2) emissions scenarios) found that, “by 2100 average sea level along the California coast may rise between 1.0 and 1.4 meters (3.3 and 4.6 feet)” (Cayan et al. 2008; Cayan et al. 2009). This magnitude of sea level rise could pose an increasing threat to energy infrastructure along the coast, including power plants, transmission and distribution lines. SCE’s analysis corroborates the findings of other researchers, discovering that *18 SCE-owned substations are at risk from a 100-year flood accompanied by a 1.4-meter sea-level rise* by the end of the century according to the data. (SCE Analysis, LBNL 2012)



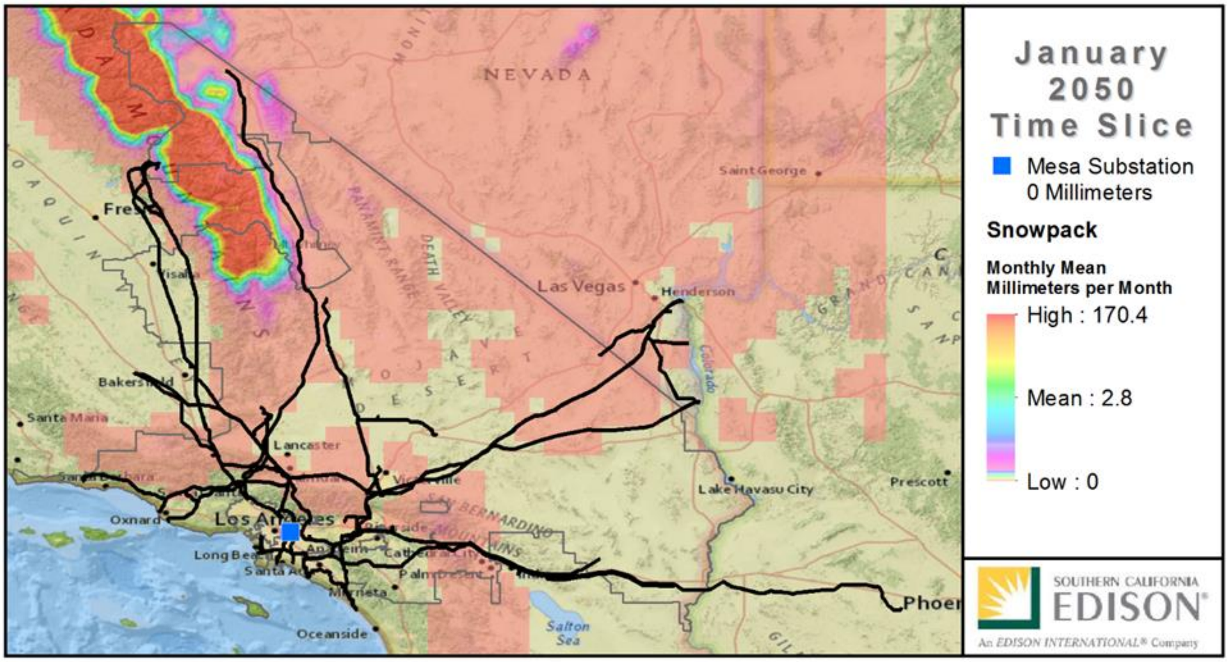
5- Precipitation and Snowpack Changes:

There will be significant challenges to California’s water systems over the next few decades. Paradoxically, “the state may very well experience both drought and increased rainfall simultaneously, with a greater share of precipitation coming from big storm events as was the case in San Diego this past July where, while in the midst of a drought, they received more rainfall in a single month than they had received in the previous 100 Julys combined” (CPUC 2016). Researchers also predict winter precipitation falling as rain instead of snowpack, which will have significant impacts on hydropower generation. The overall decrease in rainfall will result in *limited reservoir capacity available for generation needs*. Alternatively, the intensification in big storm events will *increase the risk of flooding and mudslides damaging critical equipment throughout the SCE service territory*. These projections are echoed in SCE’ analysis of data seen below and in Appendix B.





SCE's internal analysis sees a dramatic rise in January precipitation (+ 151 mm per month) and runoff +23 mm per month) at some of our hydropower facilities between now and mid-century. The impacts on hydropower generation require additional study, because specific data points fail to represent the cumulative watershed impacts of this data set. SCE will engage in this analysis over the coming months.



3.3 Electrical Utility Sector Vulnerabilities

The long-term impacts of climate change were categorized into vulnerability categories to allow for more effective mitigation strategy development. The following vulnerabilities were identified as the greatest risks facing SCE over the next 100 years due to long-term climate change impacts:

- Increased risk for facility inundation and flooding, especially at 18 at-risk coastal facilities
- Transmission, distribution, and generation systems will operate less efficiently under extreme heat
- Increased demand due to ongoing increased average temperature and extreme heat days
- Disruption of service due to facility and equipment loss following flood and landslide events
- Limited generation capacity due to decreased reservoir levels
- Disruption of service due to facility and equipment loss due to wildfire events
- Employee and public safety and wellbeing impacted by wildfire events
- Increased liability due to higher potential of utility caused fires

3.4 Estimate Consequences of Climate Change Impacts

Southern California Edison (SCE) has initiated a study on the indirect and induced costs associated with long-term climate change and the mitigations associated with overcoming them. Completing such a study in a short period is prohibitive due to the complex variables involved and the interrelated nature of associated costs. Every significant impact of climate change results in a cascading financial effect, many of which are difficult to identify and measure.

Completion of an initial impacts cost analysis is anticipated early 2017, with a detailed study slated to be completed mid-2017 to support the mitigation selection process.

Direct Costs of Climate Change Impacts

Measuring the direct costs associated with climate change over the next 100 years will require an extensive analysis of numerous variables. Factors such as increased flood risk, sea-level rise, and diminished capacity of equipment during extreme heat events all result in financial risk to SCE equipment and facilities. In order to effectively project direct costs it will be necessary to incorporate historical data, such as average facility relocation costs, with projected costs like developing technology. The following table provides an example of the direct costs associated with climate change and extreme weather impacts.

Table 3: Direct costs associated with climate change and extreme weather impacts

Climate Impact	Direct Cost of Impacts
Nuisance Flooding (Periodic, Temporary)	• Restoration and repair costs, including parts and labor • Replacement costs for damaged assets, including parts and labor • Administration of restoration and repair activities, including inspections, procurement, and installation/removal of temporary measures like portable substations
Permanent Inundation due to Sea-Level Rise	• Relocation costs, including property, infrastructure, engineering, and installation • Costs to connect relocated assets and supporting infrastructure • Replacement costs for equipment that cannot be relocated
Extreme Storm Surge Event	• Restoration and repair costs, including parts and labor • Replacement costs for damaged assets, including parts and labor • Administrative costs
Wildfire	• Inspection and repair/replacement costs for assets damaged by smoke exposure • Replacement costs for assets damaged by fire
Warmer Temperatures and Extreme Heat Events	• Restoration costs for outages • Replacement costs for equipment needing earlier replacement

Indirect and Induced Costs of Climate Change Impacts

In addition to the direct costs mentioned earlier, we also should be concerned with indirect and induced costs. These costs can have a large impact on our residential, industrial, commercial, agricultural, and infrastructure and public service customers. According to the DOE, some examples of indirect and induced costs by consumer class are shown in the table below. SCE looks forward to a continued analysis with state agencies and stakeholders.

Table 4: Indirect costs associated with climate change and extreme weather impacts

Consumer Class	Indirect Costs to Consumers	Induced Costs to Non-Consumers

Residential	• Inconvenience, lost leisure, stress, etc.
	• Out-of-pocket costs:
	    – Spoilage
	    – Property Damage
	• Health and safety effects
		• Costs to other households and firms

Industrial, Commercial, and Agricultural	• Opportunity costs of idle resources such as labor, land, and capital • Shutdown and restart costs • Spoilage and damage • Health and safety effects	• Cost on other firms that are supplied by impacted firm (multiplier effect) • Costs on consumers if impacted firm supplies a final good • Health and safety related externalities
Infrastructure and Public Service	• Opportunity cost of idle resources • Spoilage and damage	• Costs to public users of impacted services and institutions • Health and safety effects • Potential for social costs stemming from looting, vandalism

4 DEVELOPING MITIGATION STRATEGIES

4.1 SCE MITIGATION WORKSHOPS

In the summer of 2016, Southern California Edison (SCE) held a series of 'course of action workshops' meant to bring subject matter expertise together to detail specific mitigation strategies to overcome the vulnerabilities outlined in Section 3.3. The mitigation measures will continue to be refined by subject matter experts for future integration into executable mitigation plans, with detailed cost-benefit analyses outlined to facilitate the selection process. These mitigation strategies represent an initial review of the potential impacts of long-term climate change, and will require further study and analysis prior to implementation.

A summary of the mitigation strategies outlined in the course of action workshops are detailed below.

1. **Build to projected impacts**

Current policy dictates that all new facility locations are built using historical flood projects and current 100-year flood plain maps. This policy change would use maps developed using future projections and computer modelling for determining optimal building locations.

Vulnerabilities Mitigated:

- Increased risk for facility inundation and flooding, especially at 18 at-risk coastal facilities
- Disruption of service due to facility and equipment loss following flood and landslide events

Associated Costs:

- Building new facilities may become more expensive due to more stringent location requirements and environmental standards
- More analysis would be required in the planning phase of building new facilities
- This COA would have a much higher potential benefit and much lower cost than other items on this list

Associated Benefits:

- Hardened infrastructure to weather events that will become more frequent in a future climate regime
- The ability to maintain reliable service through a major weather event that would have been interrupted at a previous location

2. **Facility relocation**

Relocate facilities located in projected 100-year flood plain locations 10 years prior to flood plain encroachment.

Vulnerabilities Mitigated:

- Increased risk for facility inundation and flooding, especially at 18 at-risk coastal facilities
- Disruption of service due to facility and equipment loss following flood and landslide events

Associated Costs:

- Decommission and demolish old facilities and repurpose the land

- Cost associated with rebuilding (construction) a new facility in a potentially more costly location
- New environmental and regulatory constraints
- A move to a new location may decrease efficiency or alter how certain facilities interact with Edison infrastructure
- Potential cost associated with moving out of a projected flood plain, but in reality, the flood plain advances beyond the initial projection. This may cause the need to move once again

Associated Benefits:

- Hardened infrastructure to weather events that will become more frequent in a future climate regime
- The ability to maintain reliable service through a major weather event that would have been interrupted at a previous location
- Offers an opportunity to relocate facilities that were not places in ideal locations in the first place

3. Individual facility flood mitigation engineering

Conduct site-specific engineering review to assess the potential need for unique engineering solutions, to include but not limited to:

- Raising each site above flood plain levels
- Place critical equipment on raised or floating platforms
- Place flood berms around facilities and equipment
- Addition of seawalls in impacted communities

Vulnerabilities Mitigated:

- Increased risk for facility inundation and flooding, especially at 18 at-risk coastal facilities
- Disruption of service due to facility and equipment loss following flood and landslide events

Associated Costs:

- Construction and equipment purchase cost associated with upgrading facilities
- Potential failure of certain mitigating engineering solutions resulting in facility failure and lack of reliable service

Associated Benefits:

- Hardened infrastructure to weather events that will become more frequent in a future climate regime
- The ability to maintain reliable service through a major weather event that would have been interrupted at a previous location
- Would eliminate costs of physically moving infrastructure or procuring land

4. Equipment specifications aligned to future weather models

Current policy requires that all equipment be built to specification matching historical weather conditions for its area. This policy change would require all equipment be built to specifications matching the modeled conditions projected for the end of the equipment's lifespan (i.e. equipment with an 80 year life expectancy would have to operate effectively under the projected conditions 80 years in the future).

Vulnerabilities Mitigated:

- Transmission, distribution, and generation systems will operate less efficiently under extreme heat
- Increased demand due to ongoing increased average temperature and extreme heat days

Associated Costs:

- R&D costs associated with determining appropriately engineered equipment
- Cost of procuring and replacing the outdated equipment
- Cost of replacing equipment to climate forecast standards that may not turn out to be accurate

Associated Benefits:

- Hardened infrastructure to weather events that will become more frequent in a future climate regime
- A more accurate understanding of how your system will behave and endure the new climate and during extreme weather conditions
- Less equipment failures would decrease cost and increase safety
- Equipment that is more efficient would decrease cost in the end

5. Add equipment to reduce increased system stress

As equipment becomes less efficient due to increased temperatures and increased demand, add new equipment to reduce the burden on the existing equipment.

Vulnerabilities Mitigated:

- Limited generation capacity due to decreased reservoir levels
- Increased demand due to ongoing increased average temperature and extreme heat days
- Transmission, distribution, and generation systems will operate less efficiently under extreme heat

Associated Costs:

- R&D costs associated with determining appropriately engineered equipment
- Cost of procuring and replacing the outdated equipment as well as siting new locations for equipment

Associated Benefits:

- Increased reliability due to more contingency infrastructure in case of failure at certain points
- Increase the lifespan of older, overburdened equipment that would be negatively affected by climate change

6. Increase focus on distributed generation availability

As increased demand and decreased generation efficiency occur, focus on increasing the availability of distributed generation capacity and the ability of the grid to perform two directional flow.

Vulnerabilities Mitigated:

- Limited generation capacity due to decreased reservoir levels
- Increased demand due to ongoing increased average temperature and extreme heat days
- Transmission, distribution, and generation systems will operate less efficiently under extreme heat

Associated Costs:

- R&D costs associated with determining appropriately engineered equipment
- Costs associated with upgrading or replacing outdated equipment
- Costs associated with increased need for accurate localized load forecasts

Associated Benefits:

- Increased grid stability and reliability
- Decreases opportunities for equipment failures and costs associated with repairing or replacing the impacted equipment
- Less need for additional traditional generation

7. Increase reservoir locations and capacity

As the frequency of rain becomes less frequent but the intensity increases, the ability to capture runoff to support hydrological generation will decrease. By adding additional reservoir locations and increasing capacity, additional rain can be captured during high intensity periods of rain.

Vulnerabilities Mitigated:

- Limited generation capacity due to decreased reservoir levels

Associated Costs:

- Building new reservoirs as well as increasing the capacity of existing reservoirs would require significant construction spending
- Optimizing reservoirs would require climatological analysis, downstream water user, and environment studies
- A significant change to the system of reservoirs would increase Edison's potential exposure to infrastructure failure as well as environmental issues

Associated Benefits:

- Enhances Edison's ability to maintain hydro generation during periods of extended drought as well as optimizes the system for the anticipated changes in precipitation patterns
- Helps create a more positive public impression for Edison by showing increased water stewardship

8. Align system specifications with modified weather conditions

Model future grid development off of existing U.S. city grid design/specifications that match projected weather conditions (i.e. if 50-year weather projections for the rancho Cucamonga area match current conditions in phoenix, model grid design and requirements off of Phoenix' current design requirements.

Vulnerabilities Mitigated:

- Transmission, distribution, and generation systems will operate less efficiently under extreme heat
- Increased demand due to ongoing increased average temperature and extreme heat days

Associated Costs:

- Could present significant costs in upgrading pre-existing infrastructure and standards
- May provide for somewhat misleading solutions that work better in a different city
- The adjustments might end up being costly in the long term

- Fails to account for changes in technology over time (always looking to historical technology)

Associated Benefits:

- Utilizes pre-existing research and knowledge that may help provide realistic, workable solutions to climate change challenges
- May help to identify additional challenges or best approaches to hardening the grid

9. Increased distributed energy resources at the distribution level

Increase the use of distributed energy resources at the distribution level to reduce the load impact on the bulk transmission system.

Vulnerabilities Mitigated:

- Transmission, distribution, and generation systems will operate less efficiently under extreme heat
- Increased demand due to ongoing increased average temperature and extreme heat days
- Limited generation capacity due to decreased reservoir levels

Associated Costs:

- Significant financial impact to implement new generation capabilities throughout the SCE service territory
    - These costs could be shared across political and industry boundaries and spread out over an extended period of time if demand is forecasted long-term

Associated Benefits:

- Decreases impact on bulk transmission system
- Reduces impact of extreme heat days due to locally produced peak power production
- Greater potential for implementing 'green' power solutions

10. Multiple evacuation route policy

Implement a policy change that requires all SCE facilities to have two geographically independent evacuation routes for every Southern California Edison (SCE) facility.

Vulnerabilities Mitigated:

- Employee and public safety and wellbeing impacted by wildfire events

Associated Costs:

- Extremely costly in remote areas to develop a secondary evacuation route if none exists (i.e.; building and maintaining a new road, building a helipad)
- In some areas, the secondary evacuation route may be as vulnerable to fire as the primary evacuation route

Associated Benefits:

- Allows Edison employees to work more safely and confidently in areas of high fire risk
- Could potentially be lifesaving if fire conditions do threaten the facility

5 CHALLENGES

5.1 COMMUNITY ENGAGEMENT

SCE cannot operate independently in preparing for the impacts of global climate change. The interdependencies that exist between the utility industry, emergency management, and local communities require that any broadly implemented resilience strategy must incorporate each of these entities. One significant challenge will be aligning the mitigation strategies of SCE, with the long-term planning of local communities and emergency management organizations. For instance, attempting to move substations that may be inundated due to sea level rise must first take into account how the communities those substations serve will adapt to the same sea level rise. If the community moves, or implements coastal mitigation measures, it will significantly affect how SCE infrastructure will need to service those areas.

5.2 FINANCIAL ANALYSIS

Understanding the financial impacts of long-term climate impacts, and the role mitigation measures may have on those costs, will require extensive research and analysis. The complexity of analyzing financial impacts assessed over 100 years will necessitate the creation of a standardized model for analyzing these economic considerations across all partnering utilities to ensure consistency. At present, there is no mechanism to guide partnering utilities through this analysis.

6 NEXT STEPS

The climate is changing, and will continue changing. SCE is committed to working with the communities we serve to ensure that together we are prepared for that future.

SCE plans to continue active participation in these DOE efforts, and additionally work with state regulators in California to continue the analysis of the energy sector's climate impacts. SCE is specifically interested in pursuing the opportunities to broaden the analysis conducted so far to include California Public Utility Commission's recommendations. These recommendations urge California utilities to:

- Broaden the Definition of Assets
- Assess the System as a Sum of its Assets
- Assess Future System Assets
- Assess Emergency Management Procedures
- Assess the Vulnerability of Customers
- Assess Internal and Operational Vulnerabilities

SCE will work with DOE partners to continue assessing cost-effective mitigation measures that can address the impacts of global climate change on Southern California energy infrastructure. This work will be shared with California energy agencies, stakeholders, and our communities to promote a comprehensive understanding of the risks – and opportunities to mitigate those risks.

6.1 PLANS TO MONITOR, EVALUATE, AND REASSESS

There is a lot of uncertainty around future climate change. Southern California Edison agrees with the DOE that a robust plan should be created to address this uncertainty. Plans should include monitoring progress, evaluation of implementation and reassessing the plan. SCE will have implementation milestones, which are key points that indicate increased level of resilience to a climate threat. Key cost and performance data will also be collected and monitored.

SCE agrees with the DOE that evaluating implementation should take into account new information from outside sources. Outside sources include new climate change assessment and products form our state (ex. Cal-Adapt), US Global Change Research Program reports, DOE reports on climate change resilience planning, and NOAA climate change projections.

Reassessment is a regular part of planning and depends on how new information becomes available, urgency or how different the new information is, and resource constraints. SCE agrees with the DOE guidance that it should occur at least as often as climate change assessment reports are produced. If a change to the plan is needed, it can be individually updated starting with the step most likely to be affected.

6.2 EVALUATE AND PRIORITIZE RESILIENCE MEASURES

In mid-2017, SCE will be conducting a mitigation review process to facilitate the selection of defined long-term mitigation strategies that will be adopted across the organization. In order for any long-term mitigation strategies to be effective, they must be integrated into the highest-level of corporate decision-making, therefore, senior executives will be brought in along with subject matter experts to help facilitate the selection criterion.

6.3 DEVELOP A RESILIENCE ACTION PLAN

Once the appropriate mitigation strategies have been identified by the selection committee, a corporate resilience plan will be published, detailing how the mitigation strategies will be built into long-term planning effort across the company.

7 REFERENCES

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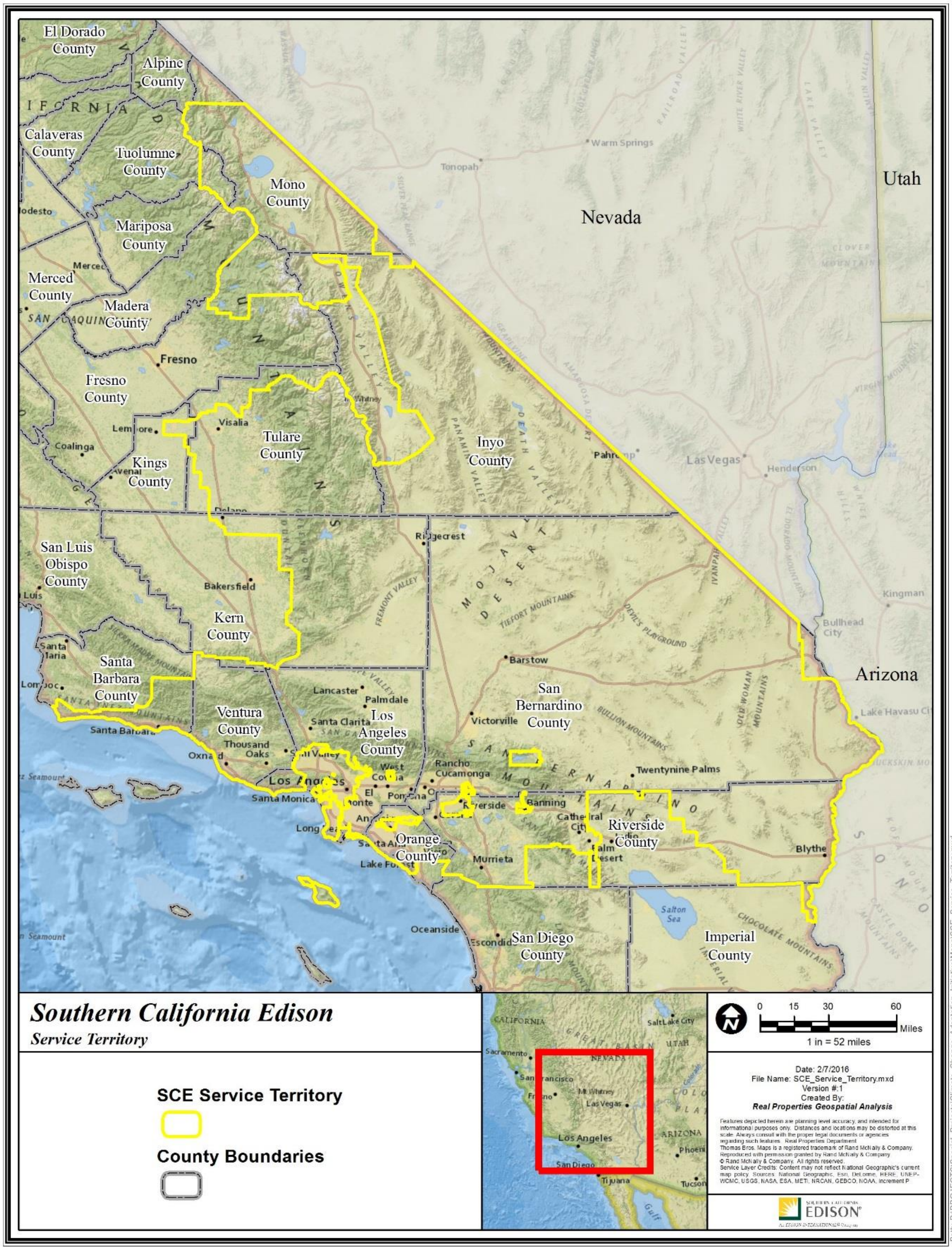
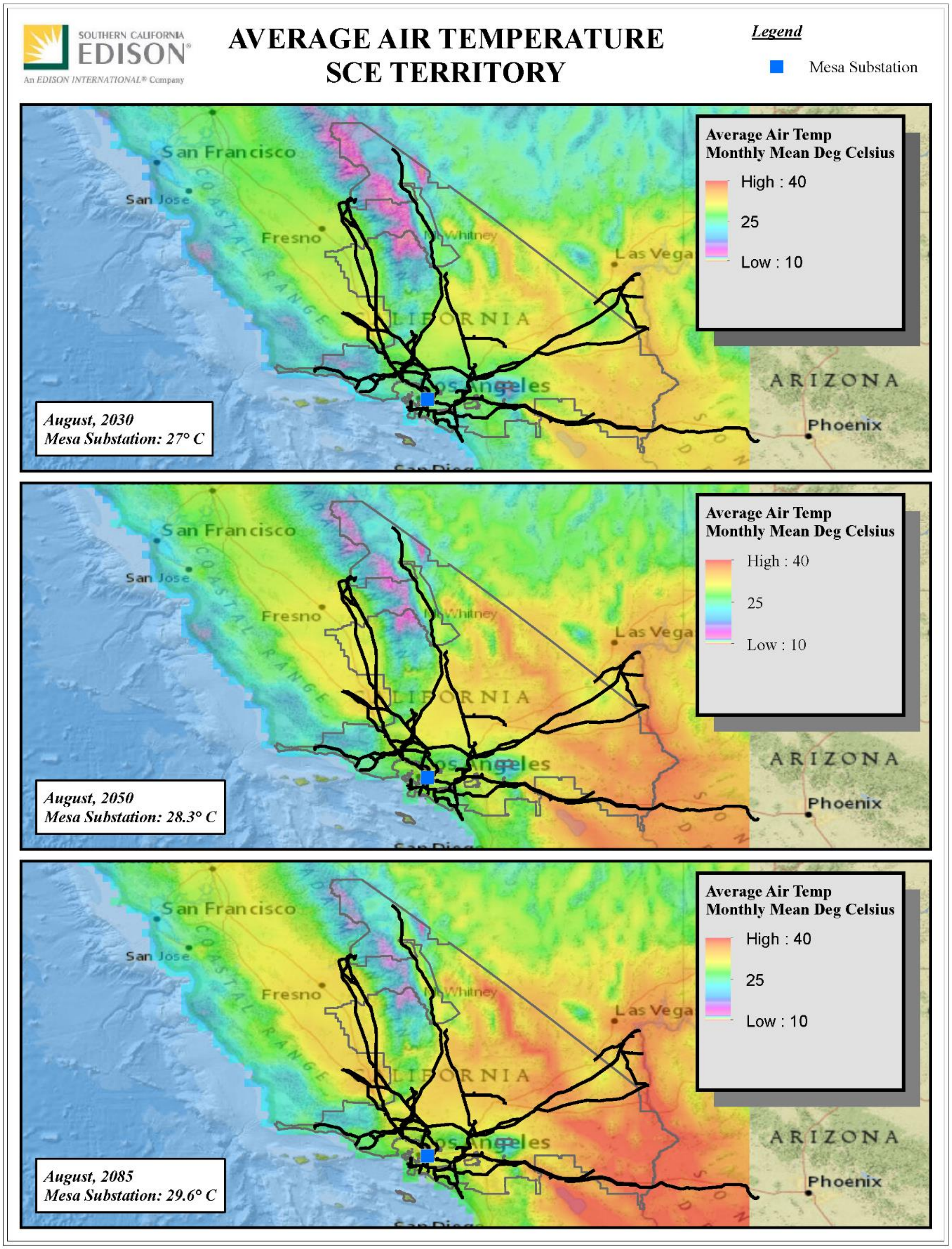
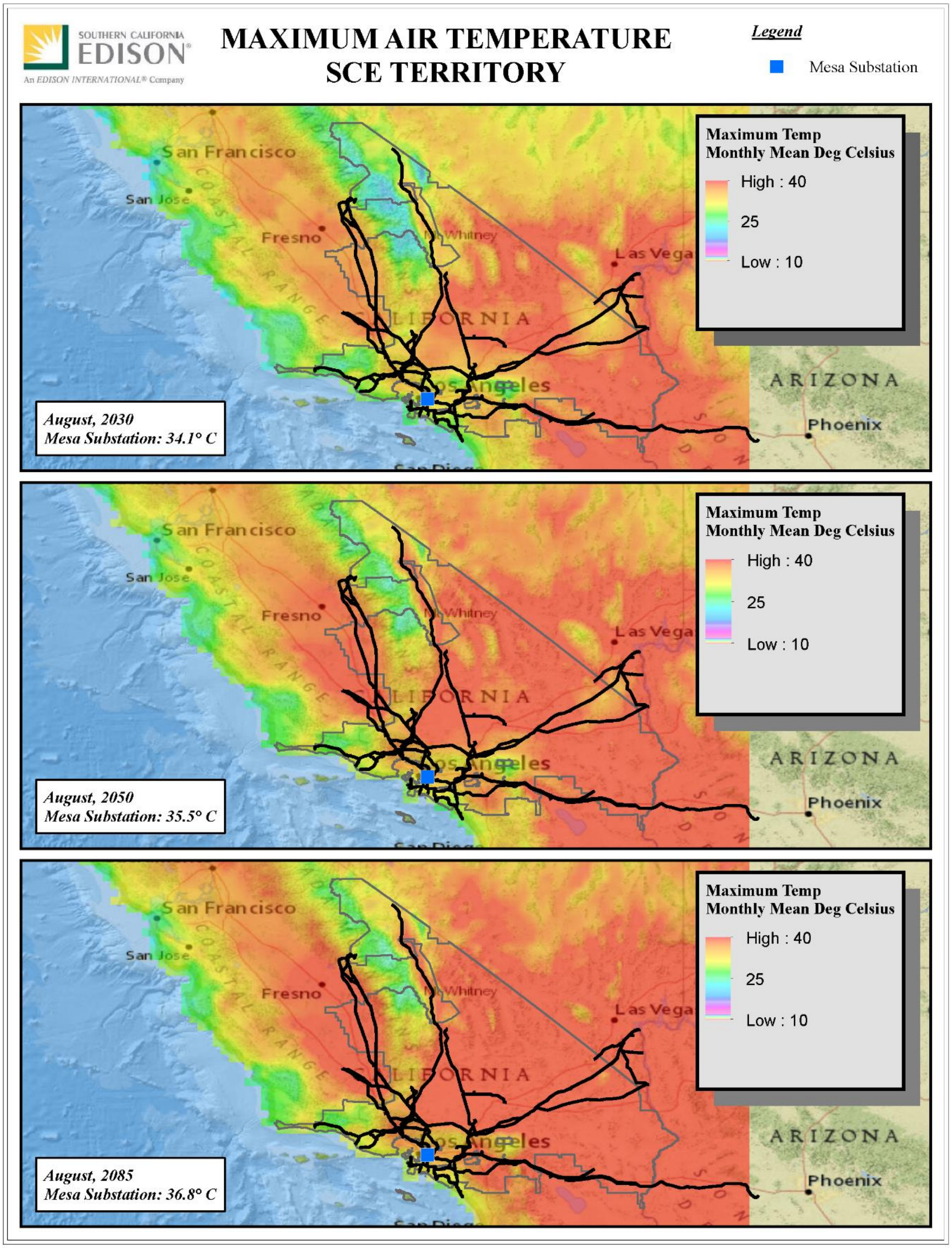
Appendix A: Map of SCE's Service Territory

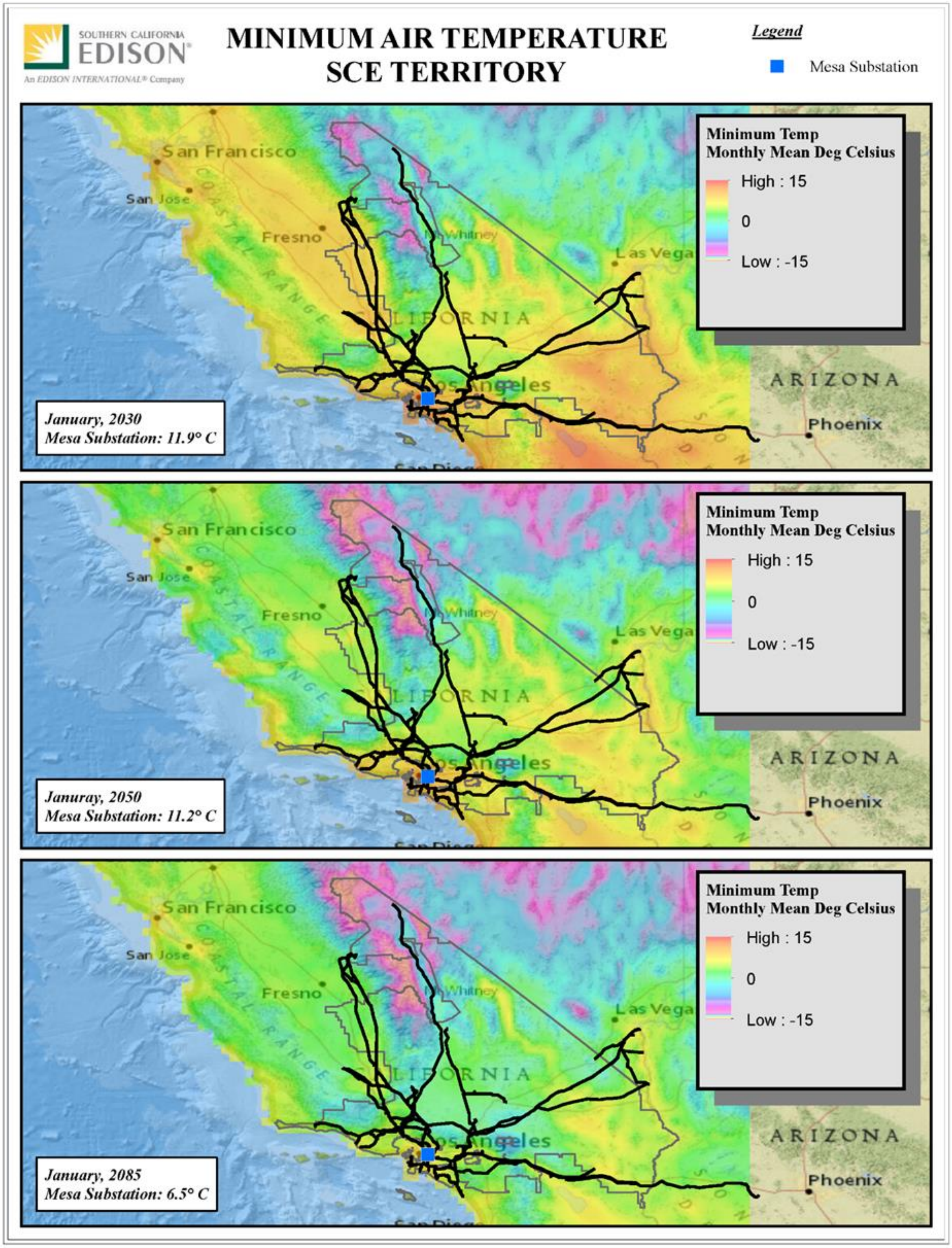


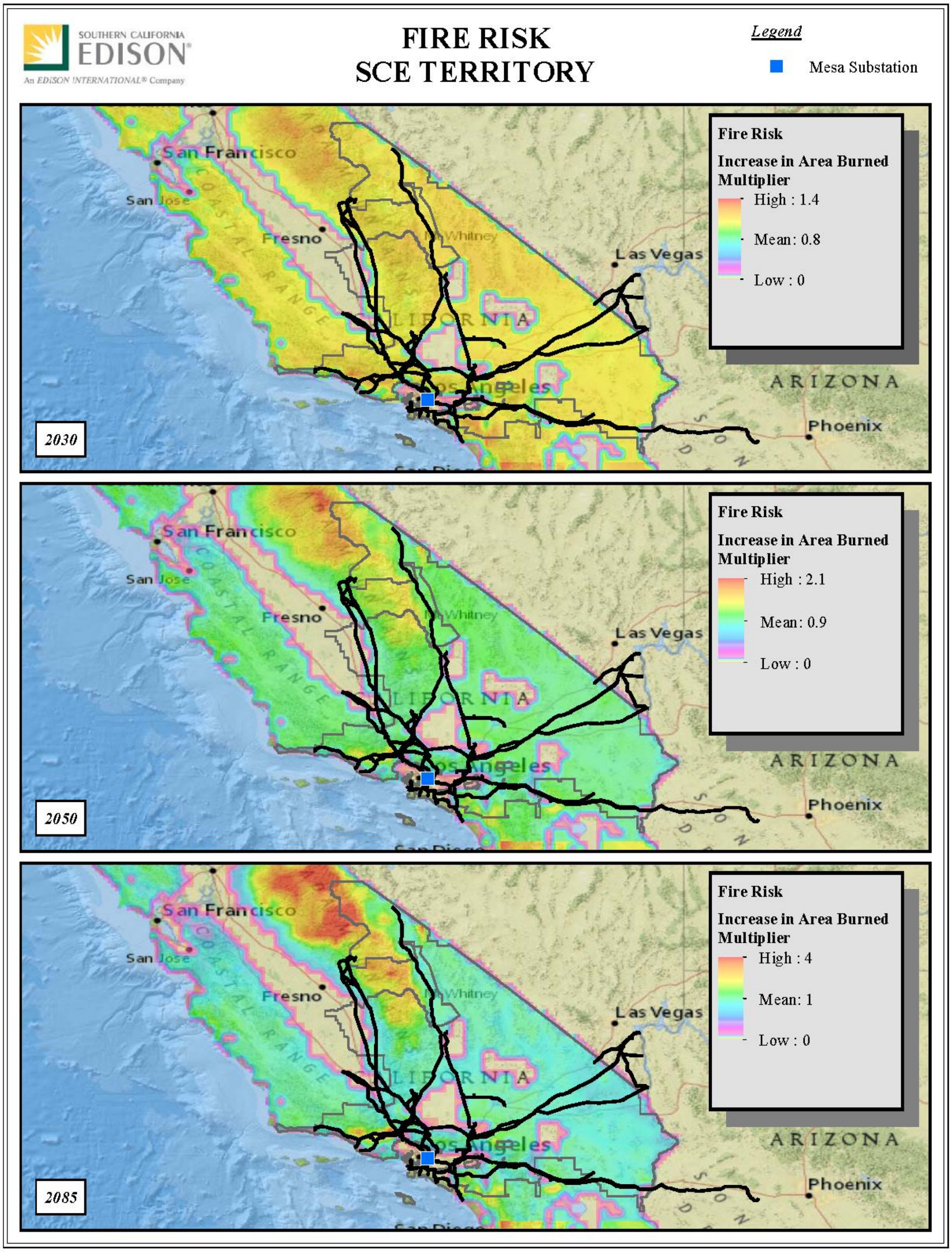
Appendix B: Side-by-side Climate Impact Maps (2030, 2050, 2085)



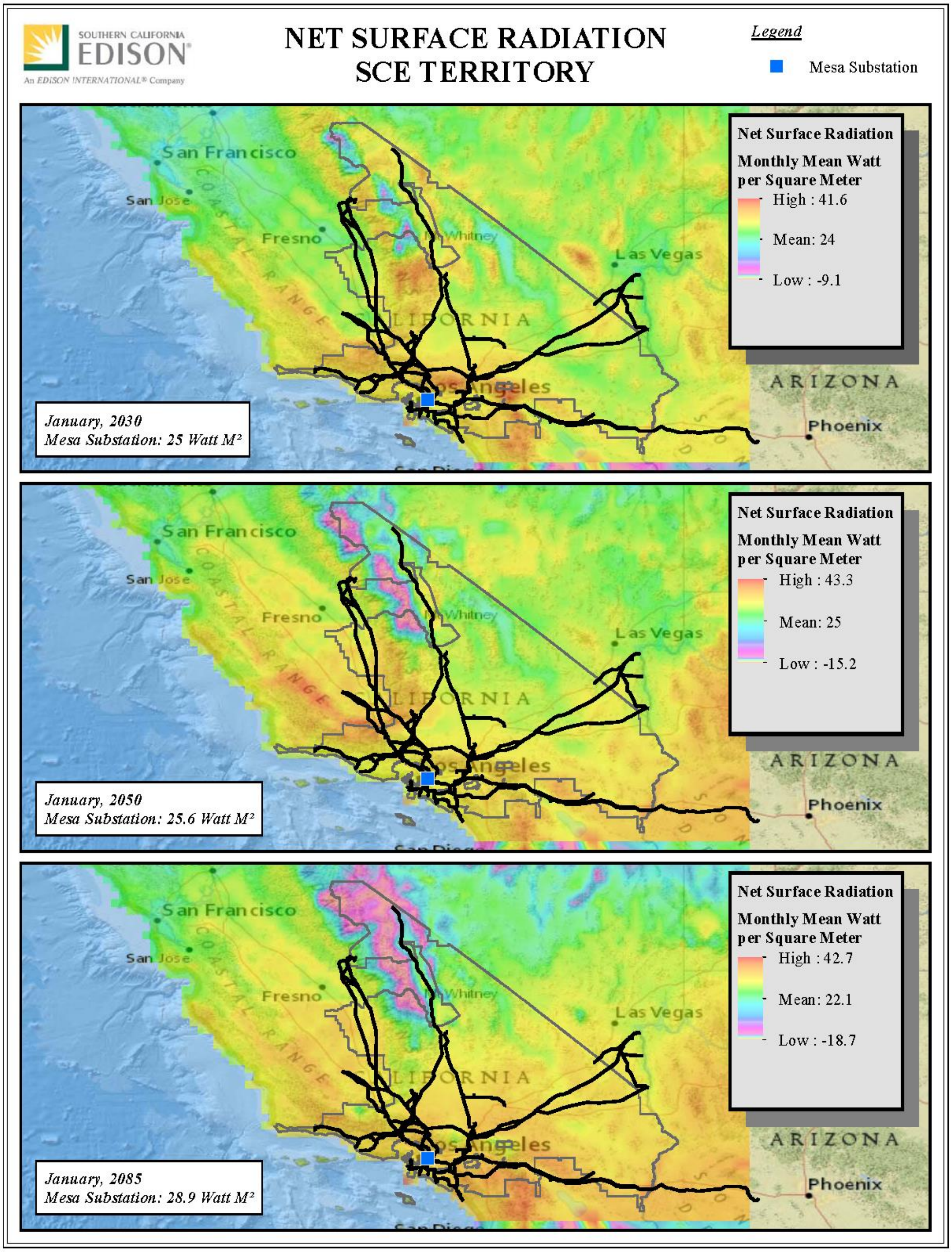


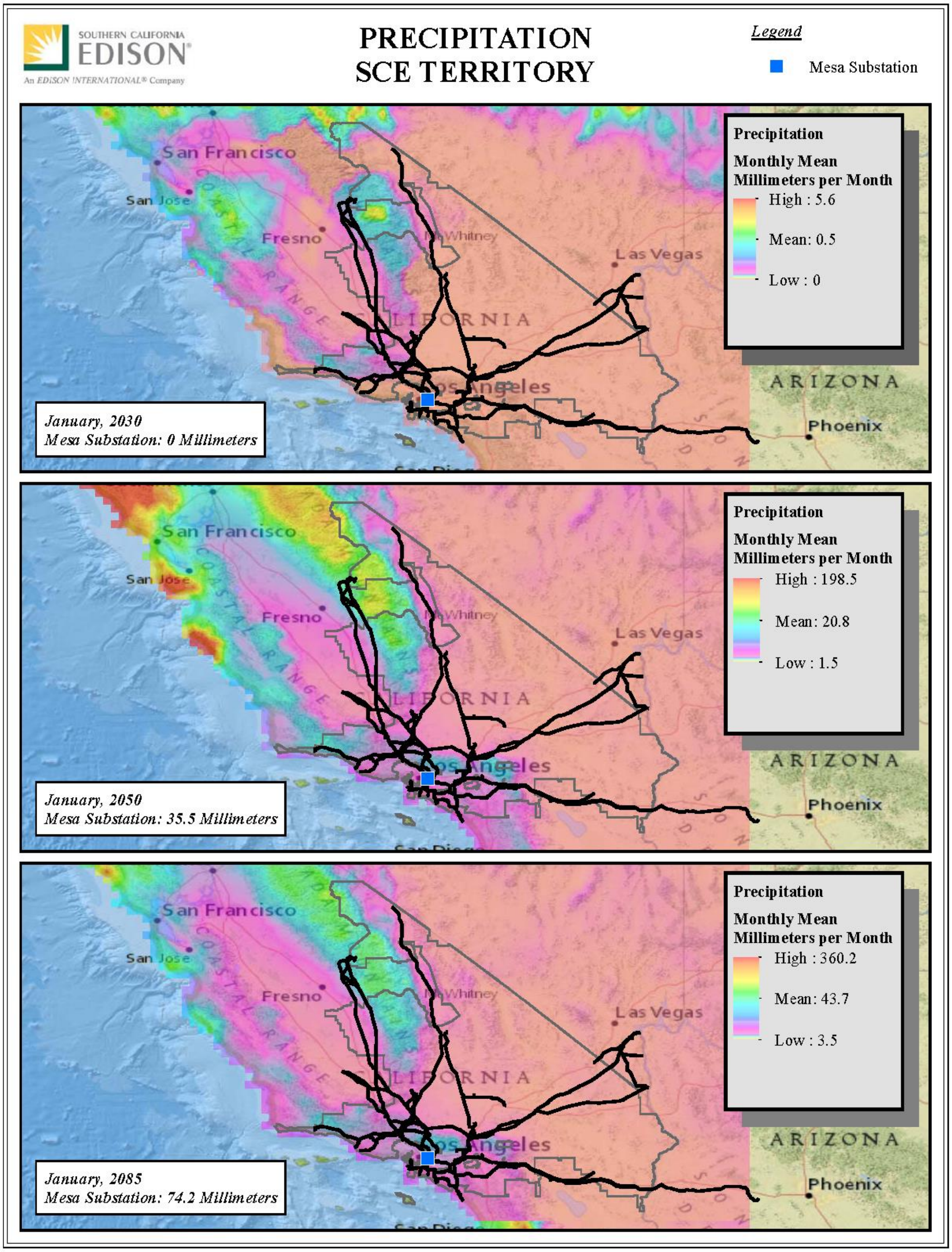
SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL® Company
MAXIMUM AIR TEMPERATURE
SCE TERRITORY
Legend
Mesa Substation
Maximum Temp
Monthly Mean Deg Celsius
High : 40
25
Low : 10
San Francisco
San Jose
Fresno
Mt Whitney
Las Vega
CALIFORNIA
Los Angeles
ARIZONA
Phoenix
August, 2030
Mesa Substation: 34.1° C
August, 2050
Mesa Substation: 35.5° C
August, 2085
Mesa Substation: 36.8° C


SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL® Company
MINIMUM AIR TEMPERATURE
SCE TERRITORY
Legend
Mesa Substation
Minimum Temp
Monthly Mean Deg Celsius
High : 15
0
Low : -15
San Francisco
San Jose
Fresno
Las Vega
CALIFORNIA
Los Angeles
ARIZONA
Phoenix
COASTAL RANGE
January, 2030
Mesa Substation: 11.9° C
Januray, 2050
Mesa Substation: 11.2° C
January, 2085
Mesa Substation: 6.5° C

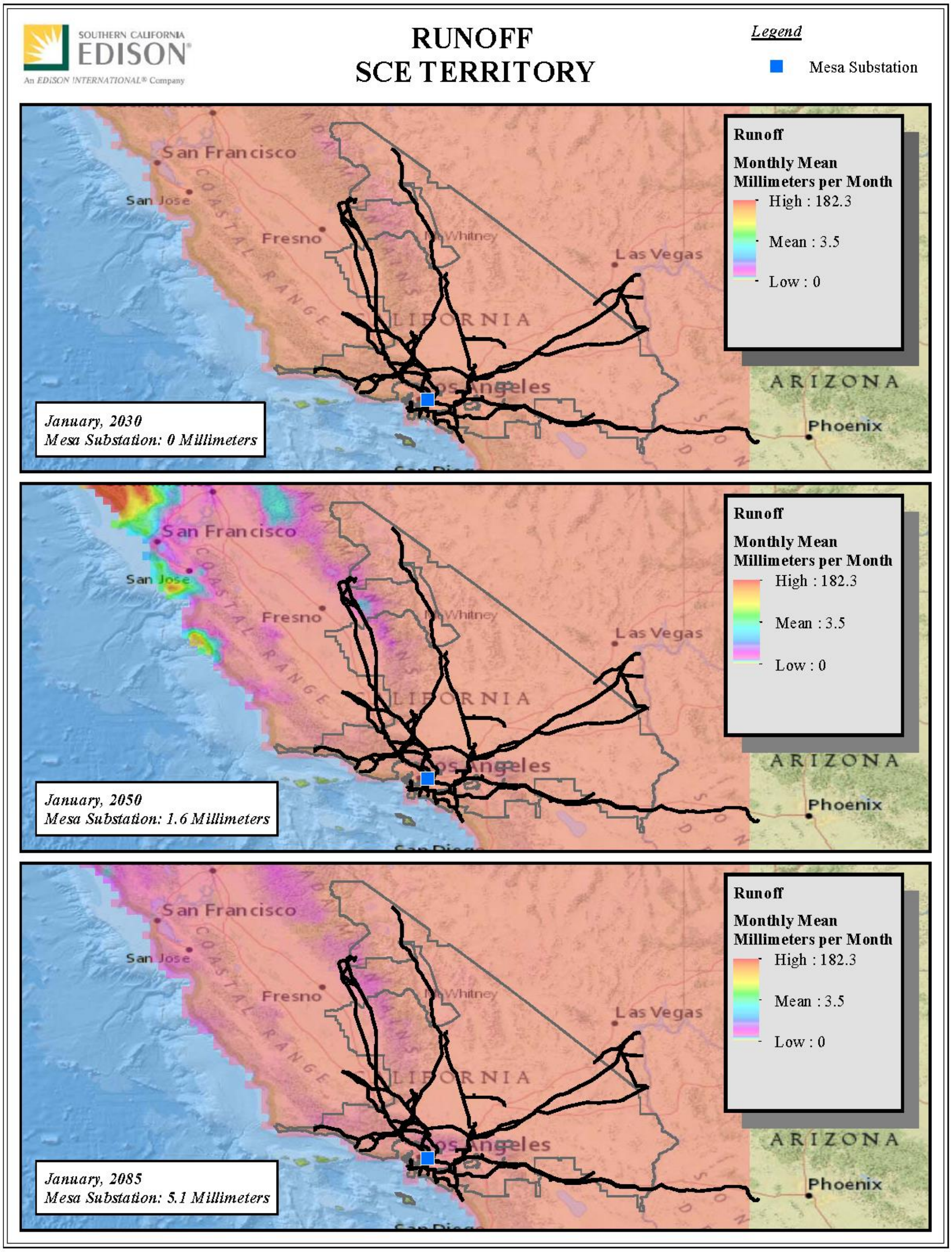


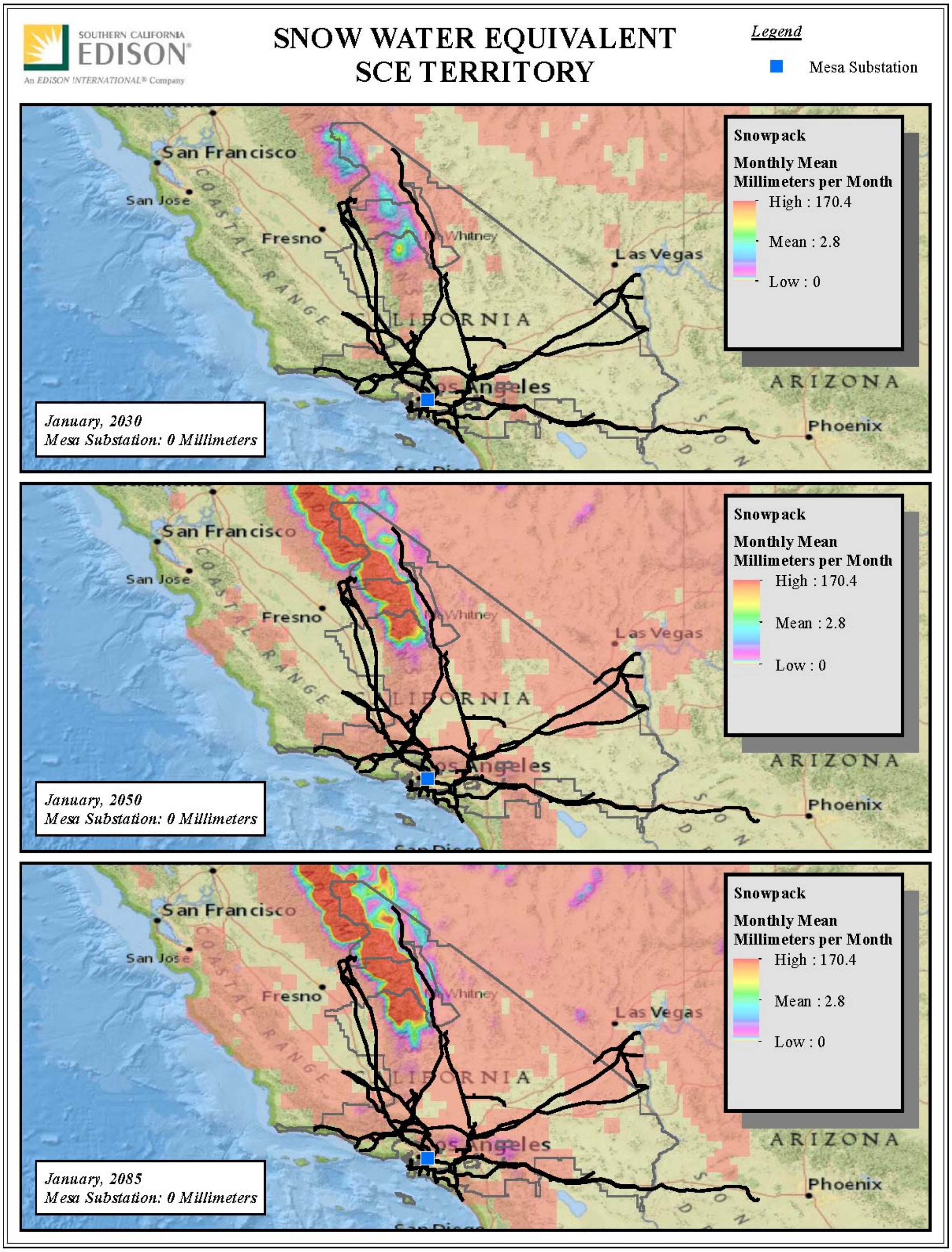
FIRE RISK
SCE TERRITORY
SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL® Company
Legend
Mesa Substation
Fire Risk
Increase in Area Burned Multiplier
High : 1.4
Mean: 0.8
Low : 0
2030
Fire Risk
Increase in Area Burned Multiplier
High : 2.1
Mean: 0.9
Low : 0
2050
Fire Risk
Increase in Area Burned Multiplier
High : 4
Mean: 1
Low : 0
2085
San Francisco
San Jose
Fresno
Las Vegas
Los Angeles
ARIZONA
Phoenix


SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL® Company
NET SURFACE RADIATION
SCE TERRITORY
Legend
Mesa Substation
Net Surface Radiation
Monthly Mean Watt per Square Meter
High : 41.6
Mean: 24
Low : -9.1
January, 2030
Mesa Substation: 25 Watt M²
Net Surface Radiation
Monthly Mean Watt per Square Meter
High : 43.3
Mean: 25
Low : -15.2
January, 2050
Mesa Substation: 25.6 Watt M²
Net Surface Radiation
Monthly Mean Watt per Square Meter
High : 42.7
Mean: 22.1
Low : -18.7
January, 2085
Mesa Substation: 28.9 Watt M²
San Francisco
San Jose
Fresno
Las Vegas
CALIFORNIA
Los Angeles
ARIZONA
Phoenix



SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL® Company
PRECIPITATION
SCE TERRITORY
Legend
Mesa Substation
Precipitation
Monthly Mean
Millimeters per Month
High : 5.6
Mean: 0.5
Low : 0
January, 2030
Mesa Substation: 0 Millimeters
Precipitation
Monthly Mean
Millimeters per Month
High : 198.5
Mean: 20.8
Low : 1.5
January, 2050
Mesa Substation: 35.5 Millimeters
Precipitation
Monthly Mean
Millimeters per Month
High : 360.2
Mean: 43.7
Low : 3.5
January, 2085
Mesa Substation: 74.2 Millimeters
San Francisco
San Jose
Fresno
Las Vegas
Los Angeles
ARIZONA
Phoenix


SOUTHERN CALIFORNIA
EDISON
An EDISON INTERNATIONAL® Company
RUNOFF
SCE TERRITORY
Legend
Mesa Substation
Runoff
Monthly Mean
Millimeters per Month
High : 182.3
Mean : 3.5
Low : 0
San Francisco
San Jose
Fresno
Mt Whitney
Las Vegas
COASTAL RANGE
CALIFORNIA
Los Angeles
ARIZONA
Phoenix
January, 2030
Mesa Substation: 0 Millimeters
January, 2050
Mesa Substation: 1.6 Millimeters
January, 2085
Mesa Substation: 5.1 Millimeters


SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL® Company
SNOW WATER EQUIVALENT
SCE TERRITORY
Legend
Mesa Substation
Snowpack
Monthly Mean
Millimeters per Month
High : 170.4
Mean : 2.8
Low : 0
San Francisco
San Jose
Fresno
Las Vegas
CALIFORNIA
Los Angeles
ARIZONA
Phoenix
COASTAL RANGE
January, 2030
Mesa Substation: 0 Millimeters
January, 2050
Mesa Substation: 0 Millimeters
January, 2085
Mesa Substation: 0 Millimeters

Southern California Edison

& the Partnership for Energy Sector Climate Resilience:

Progress Update to the Department of Energy

Section Overview:

Section 1: Summary of the Update

State regulators, Utilities, and the Academic community are increasingly seeking to understand how the wider trends of climate change at the global scale will translate into local changes in energy system performance. This report is an attempt to understand these potential impacts to SCE assets and service to our customers. SCE relied upon existing scientific literature and internal spatial analysis to illuminate the potential risks posed by future climate change. SCE will leverage this research to evaluate cost-effective mitigation strategies over the next nine months.

As a major business and significant contributor to the Southern California economy, SCE has a key role to play in identifying strategies that can meet California's regional climate adaptation strategy while continuing to ensure that electricity is safe, reliable, and affordable and clean today and in the future. With these goals in mind SCE joined the Department of Energy's (DOE) Partnership for Energy Sector Climate Resilience on July 22, 2014. As a Partner, SCE agreed to "identify priority vulnerabilities to energy infrastructure assets and operations from extreme weather and climate change impacts".

Building upon research done by the California Energy Commission (CEC) and the scientific community, SCE has created an Adaptation Planning tool that layers climate impact maps over SCE's energy infrastructure. The creation of SCE's Adaptation Planning tool embodies the 'gold standard' approach to assessing climate vulnerabilities, as described by the DOE. This approach allows SCE to draw conclusions from climate projections across the entire SCE service territory, as well as focus in on specific facilities and assets. SCE leveraged data sets provided through the State of California's CalAdapt research portal for this initial analysis, but designed the tool to be flexible enough to accept new data when it becomes available, allowing for iterative adaptation planning as the research community refines methods and gathers new insights.

SCE is the beneficiary of a community of stakeholders that have devoted significant resources to researching the impacts of climate change. SCE's climate impact analysis drew upon that existing literature to frame and focus this work. Throughout that scientific literature there is a constant refrain that climate impacts will be magnified by natural phenomena, while also changing how those natural phenomena manifest themselves. Generally speaking, natural phenomena are expected to change in their frequency, geographic scope and intensity. This means that utilities and energy regulators who are preparing for current events may need to increase their resiliency to close the risk gap created by climate change.

The following report serves as a summary of SCE's climate impact analysis. Key takeaways from the previous localized climate studies and SCE's own analysis include:

- **Population centers in Southern California to warm significantly.** The Los Angeles region is projected to see annual average air temperatures rise between 4-5 degrees Fahrenheit by mid-century, warming is greater inland, slightly less in coastal regions. (Hall 2013)
- **Extreme Heat Days (above 95F) may triple in dense urban areas near Los Angeles, the San Fernando Valley, and the San Gabriel Valley by mid-century.** Extreme Heat days may quadruple in the mountain and desert regions of SCE Service Territory over the same period. (Hall 2013)
- **Eastern transmission pathways to see significant warming, and reduced line efficiency.** According to SCE analysis and previous studies, average annual air temperature is projected to rise between 7-12 degrees Fahrenheit along the eastern boundary of SCE's Service territory by the end of the century – subjecting at least 5 key transmission pathways to some of the most extreme warming our state will face. Extreme heat events will exacerbate efficiency losses. (SCE analysis, LBNL 2012)
- **The geography of wildfire risk changing.** According to SCE's analysis of the data, this could mean tripling of wildfire risk in extreme cases in coastal regions and foothills but also slightly decreasing across the southeastern reaches of SCE's service territory (possibly due to vegetation migration) by the end of the century.
- **Sea-level rise and storms present a challenge to coastal infrastructure.** By 2100 average sea level along the California coast may rise between 1.0 and 1.4 meters (3.3 and 4.6 feet). 18 SCE-owned substations are at risk from a 100-year flood accompanied by a 1.4m sea-level rise by the end of the century according to the data. (SCE Analysis, LBNL 2012)
- **Snowpack, drought, and precipitation changes will challenge the historic reliance on hydropower to meet demand in California.** Increased variability in water resources serving California is a trend visible in SCE analysis and the scientific literature.
- **Energy demand is expected to increase.** California's third Climate Change assessment confirms that "climate change will increase demand for cooling in the increasingly hot and longer summer season and decrease demand for heating in the cooler season".

Upon a preliminary assessment of the modelling outputs, SCE's system appears resilient to the majority of projected near-term (now through 2030) impacts of climate change. Due to careful investments in energy infrastructure, adaptive capacity is built in to many of SCE's assets and operational processes. (Ex. SCE's transmission lines have a wind and temperature rating high enough to ensure service through many of the scenarios predicted into mid-century.) Comparing data projections with current on-the-ground resilience activities will be a critical part of the next phase of SCE's adaptation plan, and the DOE Partnership.

SCE plans to integrate future climate change projections into existing planning processes utilizing the tool created for this analysis. Some threat types (like wildfire, extreme heat events, and drought) have an existing planning framework that can be expanded to include longer-term data.

Utilities and regulators need to come up with best practices to address projected climate impacts. The DOE Partnership will aid this conversation, and SCE looks forward to the continued partnership.

Section 2: About Southern California Edison

At Southern California Edison we focus every day on meeting our commitments to our customers, our employees, our investors, the communities we serve, and the environment.

We are committed to safely delivering reliable and affordable electricity in a responsible manner. We know that our customers rely on us to get it right, and we must earn public trust and confidence daily. This requires a continued focus on operational and service excellence. At SCE, corporate responsibility and personal responsibility are the foundation from which we operate our business — and the heart of operational and service excellence.

Our company has been in the electric utility business for more than 125 years. Over that time, there have been dramatic changes in our communities and at SCE. Our industry is entering an era of increasing change, driven in part by public policies, advanced technologies, and the need to replace aging infrastructure. We are committed to working collaboratively with all stakeholders, including customers and public officials at all levels, to implement public policies in the most cost-effective manner.

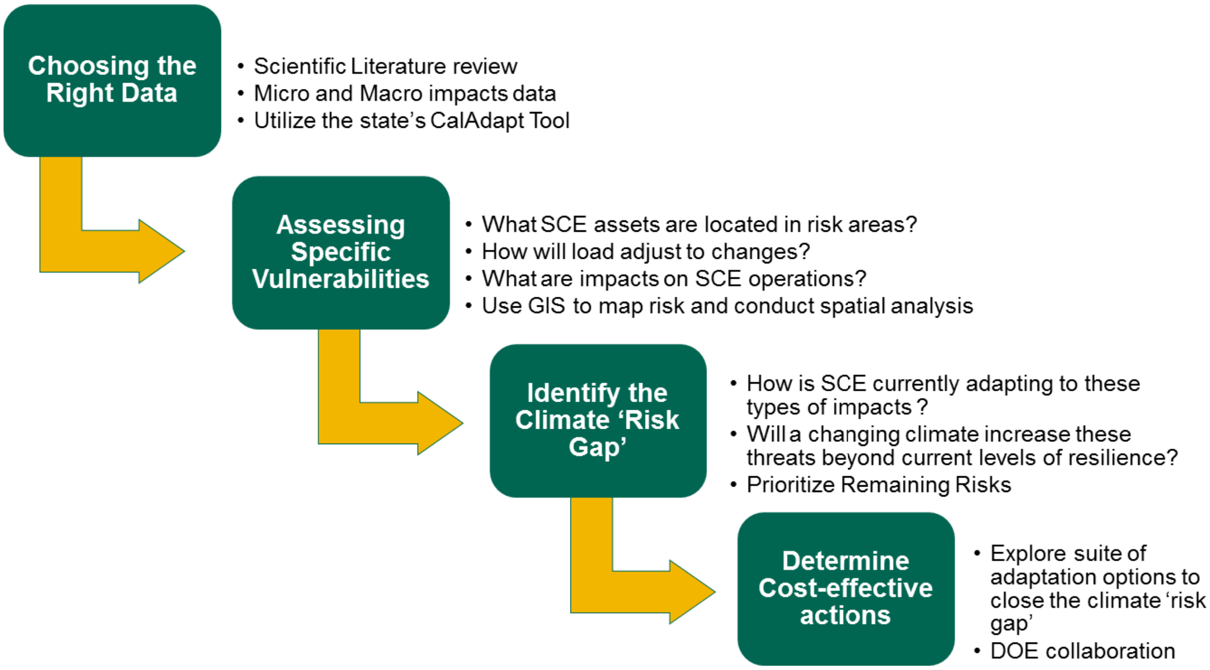
Guided by our core values of integrity, excellence, respect, continuous improvement, and teamwork, we are preparing wisely for the future in addition to taking care of day-to-day operations. This means investing billions of dollars in critical energy infrastructure to continue to provide reliable service. Although it requires significant capital investment, the good news is that our electric system is getting cleaner, smarter and more secure.

A full map of SCE's Service Territory can be viewed in Appendix A.

Section 3: SCE's Adaptation Planning Framework

SCE, in conjunction with external stakeholders has created an adaptation planning framework that functions as our DOE Partnership workplan. Key to this framework are four milestones: Choosing the Right Data, Assessing Specific Vulnerabilities, Identifying the Climate 'Risk Gap', and Determining Cost–effective Actions to address any risks discovered.

In the flow chart below, SCE has highlighted key questions to be answered, and actions to be taken, in order to achieve each milestone. Along with the DOE Partners, SCE has completed the first phase of the DOE partnership represented by the first two milestones and we will be focusing on the final two milestones in the months ahead. At this point SCE has an understanding of the potential impacts, and is now considering where risk mitigation is necessary, and which actions are appropriate to provide reliable, safe, and affordable electric service to our customers.



Section 4: SCE's Climate Impact Analysis and Adaptation Planning Tool

Choosing the Right Data

To understand how global climate change will impact local communities, researchers have refined methods of downscaling Global Circulation Models (GCM), a process which takes global-scale climatic projections and combines them with localized weather and topographical data in order to make regional climatic predictions. This progress is allowing climate scientists, state regulators, and now utilities, to speak with added confidence about the impacts Southern California could face in the decades ahead. The trend is clear, more warming can be expected, and with that warming comes additional variability across a number of weather and natural phenomena.

SCE's internal analysis, and the scientific literature reviewed, both draw from many of the same down-scaled models utilized in research funded by the California Energy Commission (e.g., Westerling and Bryant 2008; Westerling et al. 2009; Cayan et al. 2009; Heberger et al. 2009)

The projections made in this climate impact analysis stem from an emission scenario (called ‘A2’) by the Intergovernmental Panel on Climate Change (IPCC). The A2 scenario is considered to represent a medium-high emissions scenario. This scenario describes a world with a large income disparity, slow technological diffusion, and high greenhouse gas emissions. In the A2 scenario, global carbon dioxide (CO2) emissions reach nearly 30 gigatons of carbon (GtC) annually by 2100. SCE utilized this emissions scenario to conduct an internal spatial analysis because SCE is interested in exploring the extent of the climate risk gap (between current preparedness and the extremes of climate change) and also because when viewing the data it appeared that more optimistic emission scenarios track relatively near the A2 scenario in the near-term (out to 2030). SCE views this vulnerability analysis as an iterative process, and if global emissions appear to more closely follow a different emission scenario at some point in the future the tool SCE created can easily augment its assumptions by using different data sets.

Existing studies were consulted to verify analysis and draw further systemic conclusions. Two studies in particular were drawn upon to cross check SCE’s internal analysis. The first was the ‘Climate Change in the Los Angeles Region’ project run by UCLA. This project is a collection of an ongoing studies that began in 2010 and has been funded jointly by the City and County of Los Angeles, the U.S. Department of Energy, and the U.S. National Science Foundation. Another study key to our analysis was ‘Estimating Risk to California Energy Infrastructure from Projected Climate Change’ funded through the California Energy Commission’s Public Interest Energy Research (PIER) Program and authored by researchers at Lawrence Berkeley National Lab (LBNL) and UC Berkeley . When citing potential impacts from previous studies, SCE has also attempted to uniformly draw from those works the climate impacts derived from the A2 scenario (or explicitly flag the use of other scenarios) to ensure consistency.

Processing the Data

The SCE Adaptation Planning tool was designed to, but not limited to, utilize Cal-Adapts climate impact gridded time series data layers over Southern California’s energy infrastructure. By utilizing different geospatial analysis processes, this tool extracts detailed climate impact data at each asset location. The tool easily iterates over multiple locations to create a time series impact at each asset location and report impacts in a table, which allows SCE the ability to create an impact analysis by a specific assets as the impact changes into the future. Utilizing the locational aspects allows SCE to draw conclusions from climate projections across our system, as well as focus in on specific facilities and assets. The ability to conduct this type of analytic over SCE’s diverse 50,000 square mile territory ensures that SCE will be have geographic specific analysis to inform the effectiveness of mitigation strategies identified in the second phase of this effort.

The SCE Adaption Planning tool was designed for the data sets provided through the State’s Cap-Adapt research portal for this initial analysis, but SCE designed the tool to be flexible enough to accept new data when it becomes available, allowing for iterative adaptation planning as the research community refines methods and gathers additional data.

Overview of SCE Climate Impact Analysis:

1. Spatial Analysis of Climate Impacts and SCE Infrastructure
    a. Data Source: CalAdapt Climate Impact Maps
        i. IPCC Emissions Scenario: A2
        ii. Global Circulation Model: CCSM3 (if not available used PCM1)
        iii. Time slices: 2030, 2050, 2085
        iv. Threat Types considered
            1. Avg Temp - Scripps Institution of Oceanography: California Nevada Applications Program (CNAP)
            2. Fire Risk - UC Merced: Climate Applications Lab
            3. Max Temp (August) - Scripps Institution of Oceanography: California Nevada Applications Program (CNAP)
            4. Min Temp (January) - Scripps Institution of Oceanography: California Nevada Applications Program (CNAP)
            5. Net Surface Radiation - Scripps Institution of Oceanography: California Nevada Applications Program (CNAP)
            6. Precipitation - Scripps Institution of Oceanography: California Nevada Applications Program (CNAP)
            7. Runoff - Scripps Institution of Oceanography: California Nevada Applications Program (CNAP)
            8. Wind - Scripps Institution of Oceanography: California Nevada Applications Program (CNAP)
            9. Sea-Level Rise - U.S. Geological Survey (USGS)
            10. Snowpack - Scripps Institution of Oceanography: California Nevada Applications Program (CNAP)
    b. Data Source: SCE Infrastructure Maps
        i. Generation – UOG operation for all plants
        ii. Transmission – all lines >115kv
        iii. Substation – all stations
        iv. Distribution – aggregate high-level risks

Prioritizing and Assessing Specific Vulnerabilities:

SCE's analysis focused on understanding the climate impacts projected to occur to the energy assets that customers most heavily rely upon, and which SCE controls. As mentioned in the overview of SCE's analysis above, this included utility–owned generation, transmission lines > 115kv, all substations, and a high-level look at distribution system impacts.

While there is still significant uncertainty regarding the likelihood of specific downscaled impacts at specific locations, focusing SCE's analysis at the facility (or asset) level has provided insights into trends and specific concerns that require additional analysis. The data breakouts below offer a representative look at how facility-level data can be generated from SCE's Adaptation Planning tool. This facility-level data combined with a thorough review of the scientific literature and a deep understanding of the challenges facing the SCE system, has allowed SCE to prioritize the list of assets being studied and will allow SCE to understand where our system may be vulnerable at the state, regional and facility-level.

These facility-level outputs provides SCE with a robust and flexible dataset that can be subjected to additional statistical methods and spatial analysis. For example, while the snowpack data for Big Creek Hydro Generation found in the second table below is only representative of impacts at a specific facility, not the total watershed, with the understanding of the geographic scope of that watershed, spatial analysis can reveal the total impacts to hydro production for the region. The same type of analysis can be applied to other impact types, such as the demand effects of 'August average air temperature' in a specific CEC Climate zone.

Example of Facility-level Analysis Outputs

Mesa Substation	2030 (2020 for Fire Data)	2050	2085
AvgAirTemp (c) Aug.	27	28.3	29.6
FireRisk Multiplier	0	0	0
MaxAirTemp (c) Aug.	34.2	35.5	36.8
MinAirTemp (c) Jan.	11.9	11.2	6.5
NetSurfRadi (watt per square meter)	25	25.6	28.9
Precip (mm per month) Jan.	0	35.4	74.2
Runoff (mm per month) Jan.	0	1.6	5.1
SnowWaterEquiv (mm per month) Jan.	0	0	0

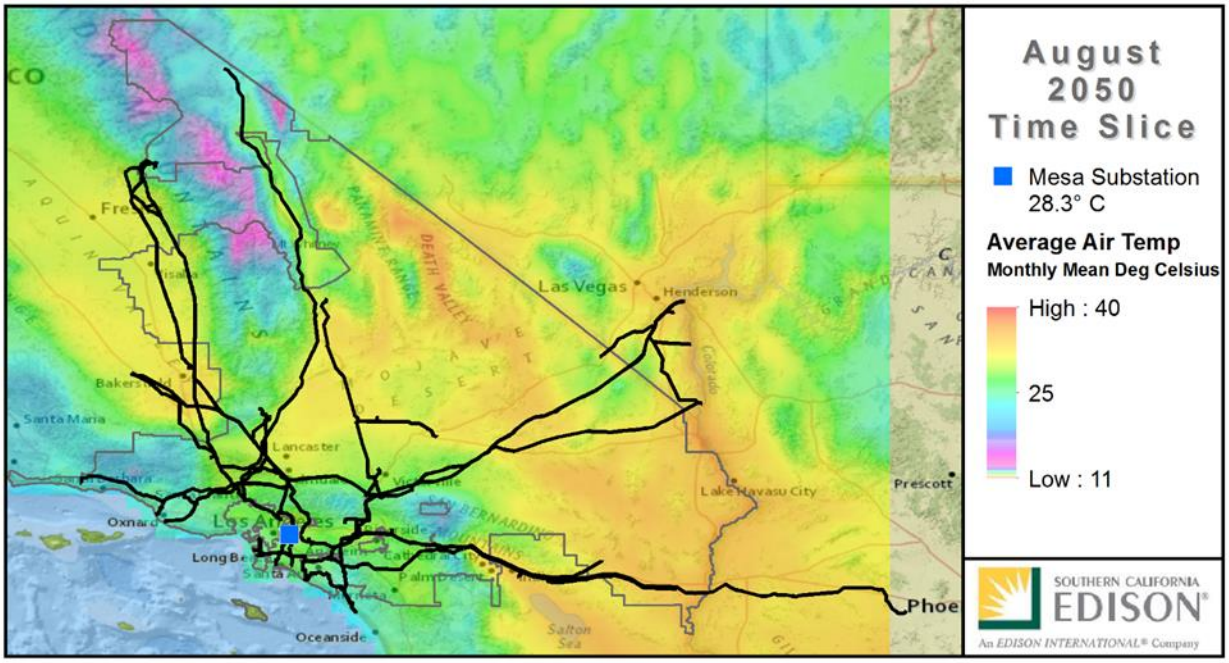
Big Creek #1- Hydro Generation	2030 (2020 for Fire Data)	2050	2085
AvgAirTemp (c) Aug.	18.5	20.2	20.6
FireRisk Multiplier	1	1.3	1.6
MaxAirTemp (c) Aug.	24.9	27.9	27.6
MinAirTemp (c) Jan.	-0.3	-3.4	-4
NetSurfRadi (watt per square meter)	33.5	27.9	14.3
Precip (mm per month) Jan.	2	152.9	196.2
Runoff (mm per month Jan.	0	23.6	20.4
SnowWaterEquiv (mm per month) Jan.	0	68.3	52.3

Section 4: Summary of Potential Impacts

The following section describes the climate impacts most likely to impact SCE's operations and assets. Drawing upon relevant previous studies and our own analysis, SCE presents below a summary of key findings and climate impact maps for the year 2050. Additional impact maps showing 2030, 2050, and 2085 snapshots side-by-side for reference are located in Appendix B, at end of this update.

Warming Temperatures:

According to research conducted by Cayan et al. (2009) mean temperatures in California are expected to warm significantly over the twenty-first century in all widely studied climate scenarios, especially in the summer and in inland areas. At a more regional scale, by mid-century, Hall et al. (2013) find the most likely warming under the business-as-usual scenario is roughly 4.6 degrees Fahrenheit averaged over the LA region's land areas, with a 95% confidence that the warming lies between 1.7 and 7.5 degrees. The high resolution of their projections reveals a pronounced spatial pattern in the warming: High elevations and inland areas separated from the coast by at least one mountain complex warm 20% to 50% more than the areas near the coast or within the Los Angeles basin (Hall 2013). Moving beyond mid-century and urban centers, SCE's analysis finds the eastern border of the service territory may see average monthly ambient air temperature increases between 7 and 12 degrees Fahrenheit in the 2070-2099 period. This region hosts five key transmission pathways serving load to southern California.



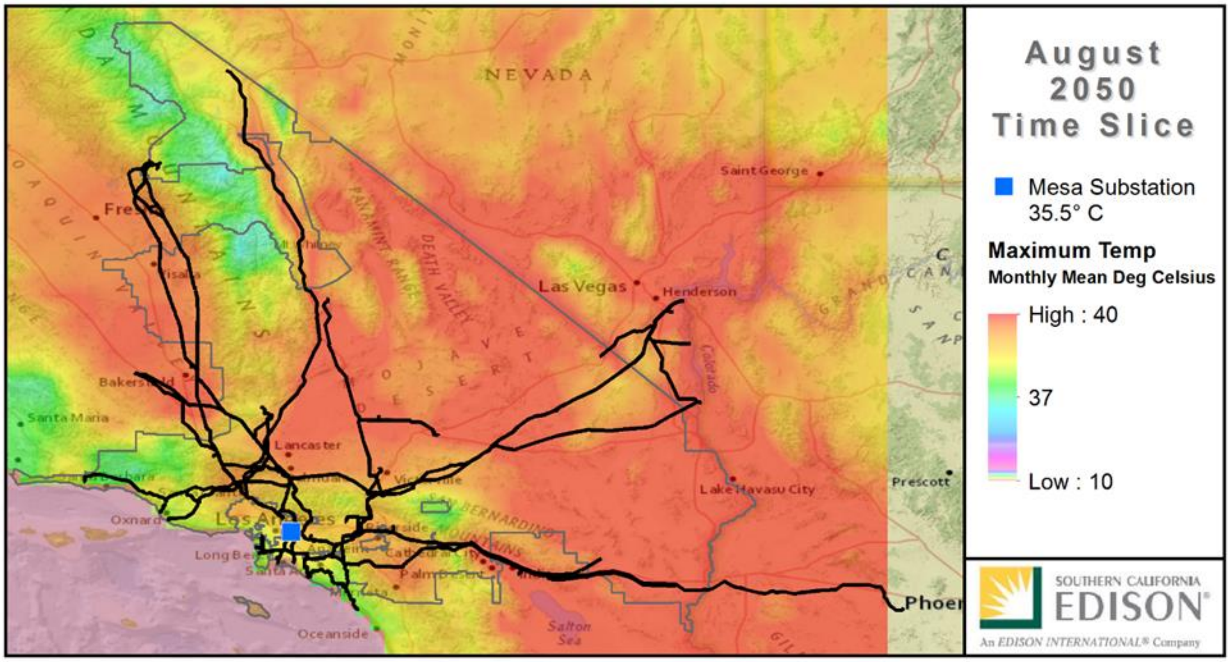
Extreme Heat Events:

According to research from Hall et al. (2013) on the impacts of climate change on the broader LA Region,

> "The number of extreme heat days, defined as days in which the high temperature exceeds 95 degrees Fahrenheit, rises everywhere at mid-century under the business-as-usual scenario. The number of extreme heat days in the future follows a similar spatial pattern to that of the warming results, with inland areas seeing much higher totals than coastal areas. For example, Santa Barbara sees average annual extreme heat days rise from 5 in the baseline period to more than 123 at mid-century under business-as-usual. By contrast, Riverside sees an increase from 58 days to 103 days."

Overall, this research finds a tripling of extreme heat days by mid-century in dense urban areas in Los Angeles County, the San Fernando Valley and San Gabriel Valley.

Historically, most Southern California heat waves have occurred in July and August, but as climate warming occurs, these events appear to begin earlier in the season and could continue through the Fall, while summer events become more frequent and more intense. The increasing tendency for multiple hot days in succession – resulting in heat waves that last longer – could cause problems for distribution infrastructure as well as transmission. Especially important may be the lack of night-time cooling that has characterized recent heat waves in California, which can cause additional stress on the transformers that help serve customer load.



High temperatures can also result in decreased efficiency in generation. The LBNL (2012) study finds that higher temperatures will decrease the capacity of existing natural gas-fired power plants during extreme heat events. While they note that the estimated decrease in capacity varies (by region, emission scenario, climate model, and plant type) the trend is clear. During the hot periods of August at the end of the century, under the high emission scenario, the models used for this study estimate a decrease in natural gas power plant generating capacity of 3 percent to 6 percent in California. To put this phenomenon in perspective, total nameplate Capacity losses at California's gas-fired generating plants could total 10.3 GW on hot days by the end of the century (LBNL 2012). This should be compared with the 1961–1990 maximum coincident loss of 7.6 GW.(LBNL 2012)

The transmission of electricity will also be affected by increased ambient air temperature and extreme heat events. As described in the State of California's Third Climate Change:

> "In addition to reduced efficiency in the electricity generation process at natural gas plants, reduced hydropower generation, losses at substations, and increasing demand during the hottest periods (resulting in more than 17 Gigawatts or 38 percent of additional capacity needed by 2100 due to higher temperatures alone), transmission lines lose 7 percent to 8 percent of transmitting capacity in high temperatures while needing to transport greater loads."

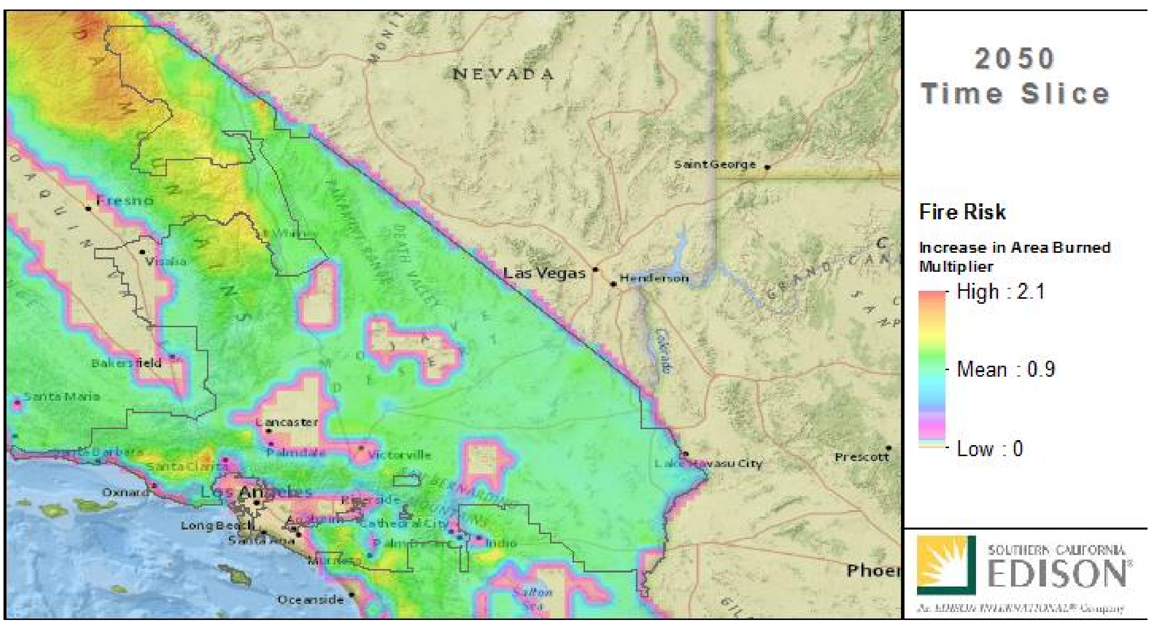
According to SCE analysis and previous studies, average annual air temperature is projected to rise between 7-12 Farenheit along the eastern boundary of SCE's Service territory by the end of the century – subjecting at least 5 key transmission pathways to some of the most extreme warming our state will face. (SCE analysis, LBNL 2012) According to the LBNL study, a 9 degree Fahrenheit air temperature increase (the average increase predicted for hot days in August according to the Intergovernmental Panel on Climate Change's A2 scenario) diminishes the capacity of a fully loaded transmission line by an average of 7.5 percent. (LBNL 2012) This warming and increased chance of extreme heat will posing key risk due to the fact that Southern California draws on imports coming east for about one-third of its needs.

Increased Wildfire Risk:

Of the most damaging fires in the United States over the last 170 years, more than half occurred in California, and California leads the nation in economic losses from wildfire (Fried et al. 2004; Torn et al. 1998). Southern California wildfires can be a serious threat to electrical transmission and distribution lines, as they can result in increased maintenance costs and reduced line efficiency. As noted in the scientific literature, wildfire risk is influenced by a number of factors, including climate, topography, available fuel, and sources of ignition (Westerling et al. 2009). From studying the data, it seems that climate change will only exacerbate the problem, as increased temperatures, a reduced snowpack, and altered precipitation will lead to increased flammability of fuel for longer periods of time, which will affect the size, frequency, and severity of wildfires (LBNL 2012).

One study summarized in California's Third Assessment finds, "a 40 percent increase in the probability of wildfire exposure for some major transmission lines, including the transmission line bringing hydropower from the Pacific Northwest into California during peak demand periods" (Third Assessment 2012).

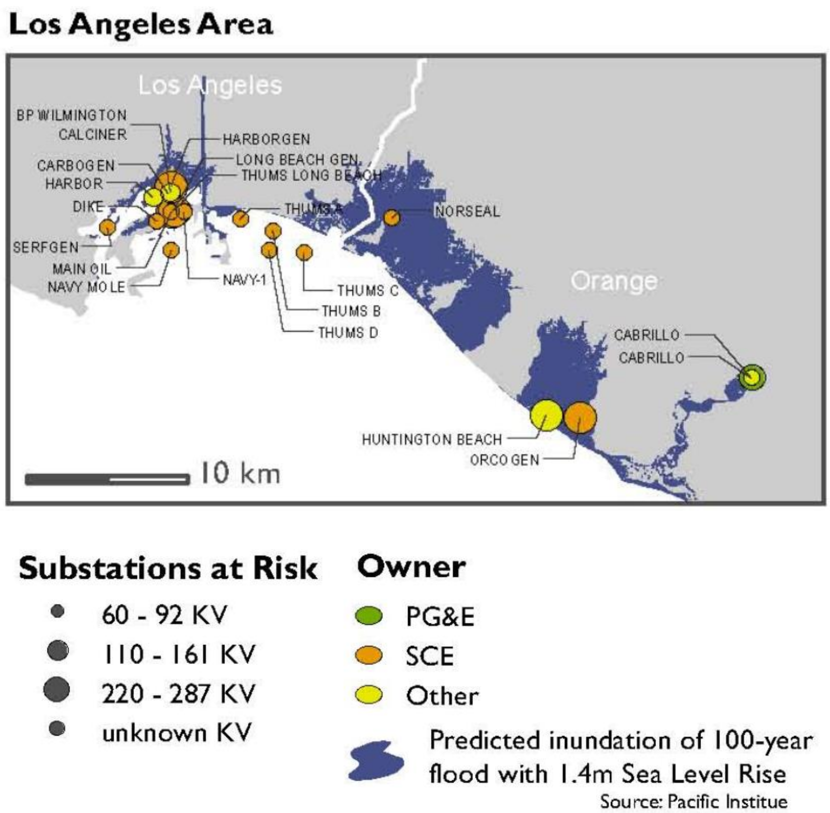
According to SCE's analysis of the data, this could mean tripling of wildfire risk in extreme cases (ex. near transmission lines serving Santa Barbra) but also slightly decreasing risk across the southeastern reaches of SCE's service territory (possibly due to vegetation migration) by the end of the century.



SCE currently utilizes CAL FIRE data, and on–the-ground inspections, to assess threats to SCE's system from wildfire. However, CAL FIRE's Fire and Resource Assessment Program Fire Threat Map hasn't included the explicit impacts of increased fire risk due to climate change. SCE will seek to integrate this climate change data into its planning process and risk maps.

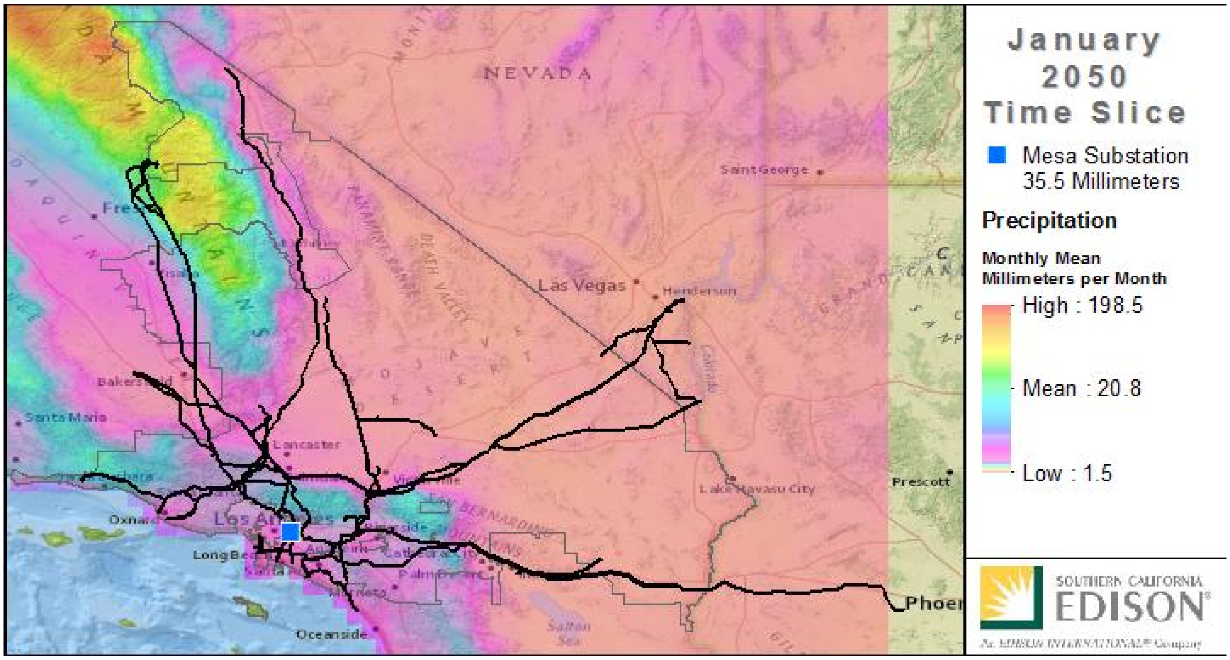
Sea Level Rise/ Coastal Inundation:

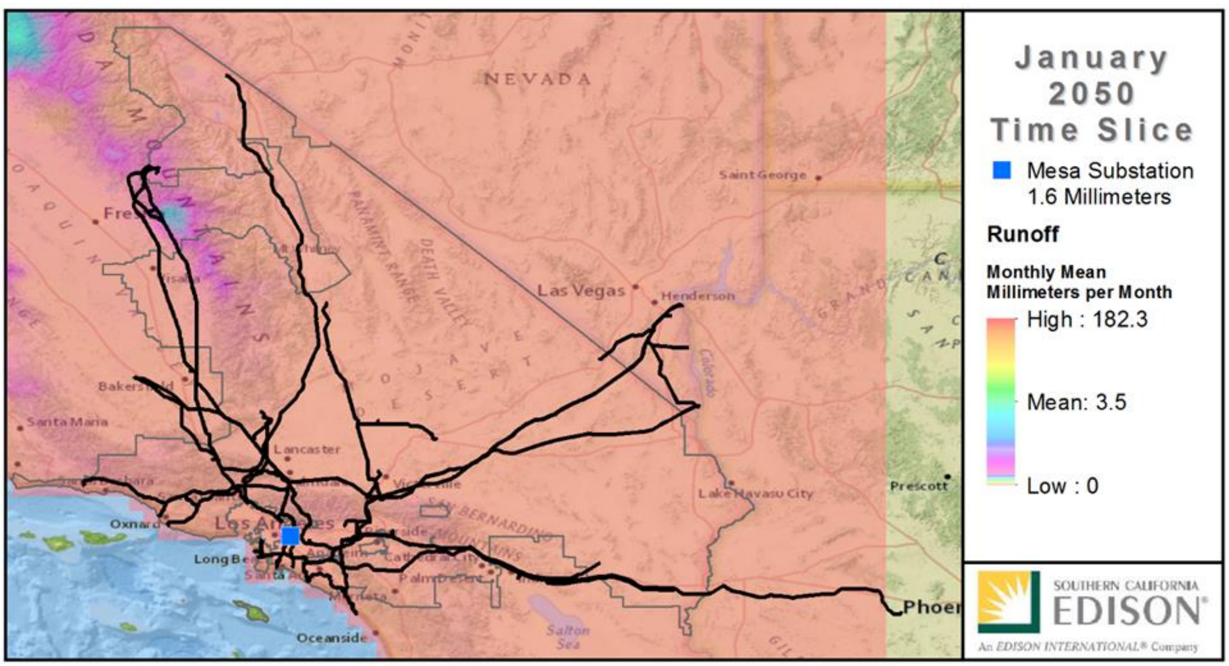
Sea level along California's coast has risen about 17–20 centimeters (cm) over the last century, and many studies anticipate a larger rise over the coming century (Cayan et al. 2009). Researcher studying the impacts of climate change (specifically the low (B1) to medium-high (A2) emissions scenarios) found that, "by 2100 average sea level along the California coast may rise between 1.0 and 1.4 meters (3.3 and 4.6 feet)" (Cayan et al. 2008; Cayan et al. 2009). This magnitude of sea level rise could pose an increasing threat to energy infrastructure along the coast, including power plants, transmission and distribution lines. SCE's analysis corroborates the findings of other researchers, discovering that 18 SCE-owned substations are at risk from a 100-year flood accompanied by a 1.4m sea-level rise by the end of the century according to the data. (SCE Analysis, LBNL 2012)



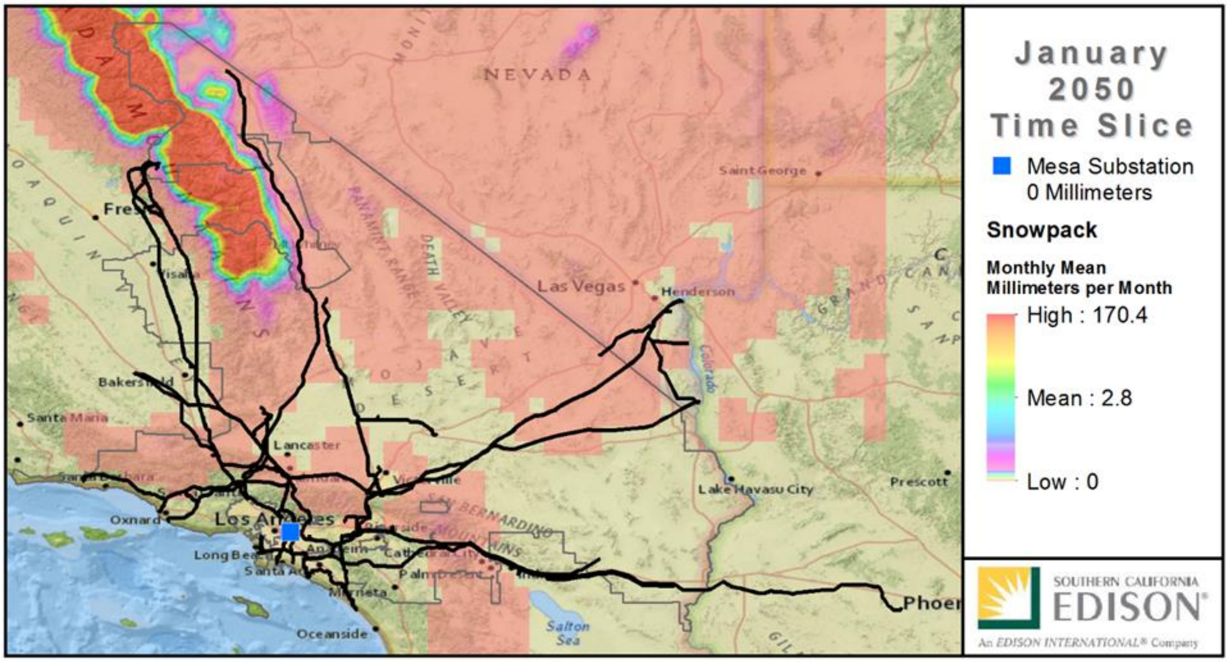
Precipitation and Snowpack Changes:

There will be significant challenges to California's water systems over the next few decades. Paradoxically, "the state may very well experience both drought and increased rainfall simultaneously, with a greater share of precipitation coming from big storm events as was the case in San Diego this past July where, while in the midst of a drought, they received more rainfall in a single month than they had received in the previous 100 Julys combined" (CPUC 2016). Researchers also predict winter precipitation falling as rain instead of snowpack which will have significant impacts on hydropower generation. These projections are echoed in SCE' analysis of data seen below and in Appendix B.





SCE's internal analysis sees a dramatic rise in January precipitation (+ 151 mm per month) and runoff +23 mm per month) at some of our hydropower facilities between now and mid-century. The impacts on hydropower generation require additional study, because specific data points fail to represent the cumulative watershed impacts of this data set. SCE will engage in this analysis over the coming months.



Section 5: Regional Collaboration

In order to best meet the challenges of a changing climate, SCE continues to partner with regional stakeholders to assess the resiliency of the communities we serve and collaborate on the challenges we all collectively face.

In order to further that aim, SCE has joined the Mediterranean City Climate Change Consortium (MC-4). It is the leading network for building resiliency to climate change among cities in Mediterranean-climate regions.

The MC-4 network provides us the opportunity to coordinate our efforts across political borders and disciplines to find solutions. Through an international network of experts and practitioners, MC-4 is leading research addressing the impacts of climate change on our communities and developing technical tools for cities to adopt as they engage in their own strategic planning. MC-4 seeks to build and sustain integrated cities – cities that are developed holistically as livable, connected, sustainable spaces and provide for the social, economic and environmental health of Mediterranean regions.

SCE will continue to engage with local stakeholders, especially during the next phase of the DOE partnership timeline, where solutions will be determined.

Section 6: Conclusion and Next Steps

The climate is changing, and will continue changing. SCE is committed to working with the communities we serve to ensure that together we are prepared for that future.

SCE plans to continue active participation in these DOE efforts, and additionally work with state regulators in California to continue the analysis of energy sector climate impacts. SCE is specifically interested in pursuing the opportunities to broaden the analysis conducted so far to include California Public Utility Commission‘s recommendations. These recommendations urge California utilities to:

- Broaden the Definition of Assets
- Assess the System as a Sum of its Assets
- Assess Future System Assets
- Assess Emergency Management Procedures
- Assess the Vulnerability of the Customers
- Assess Internal and Operational Vulnerabilities

Over the next nine months SCE will work with DOE partners to assess cost-effective mitigation measures that can address the impacts of global climate change on shared energy infrastructure. This work will be shared with California energy agencies to promote a comprehensive understanding of the risks and opportunities to mitigate those risks.

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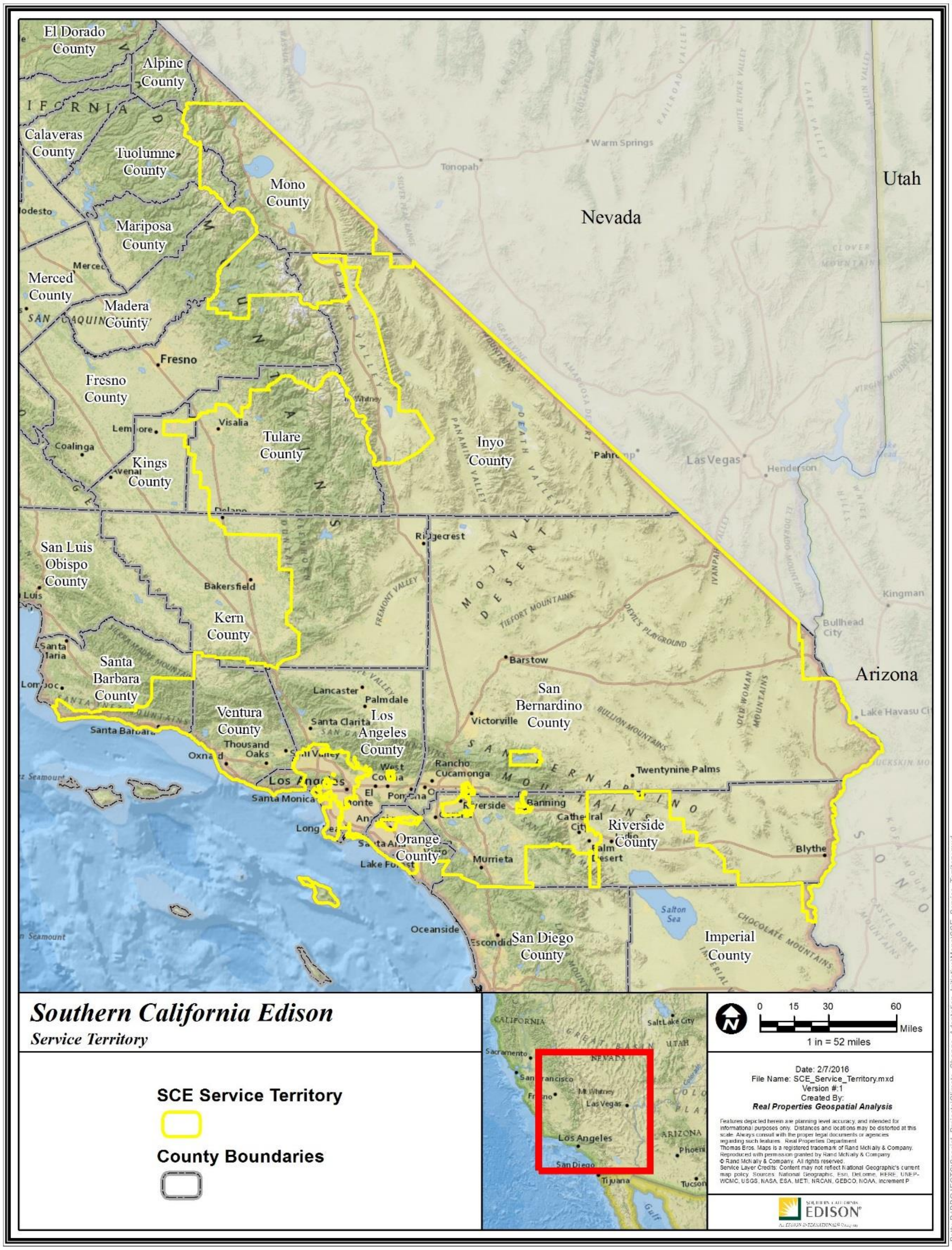
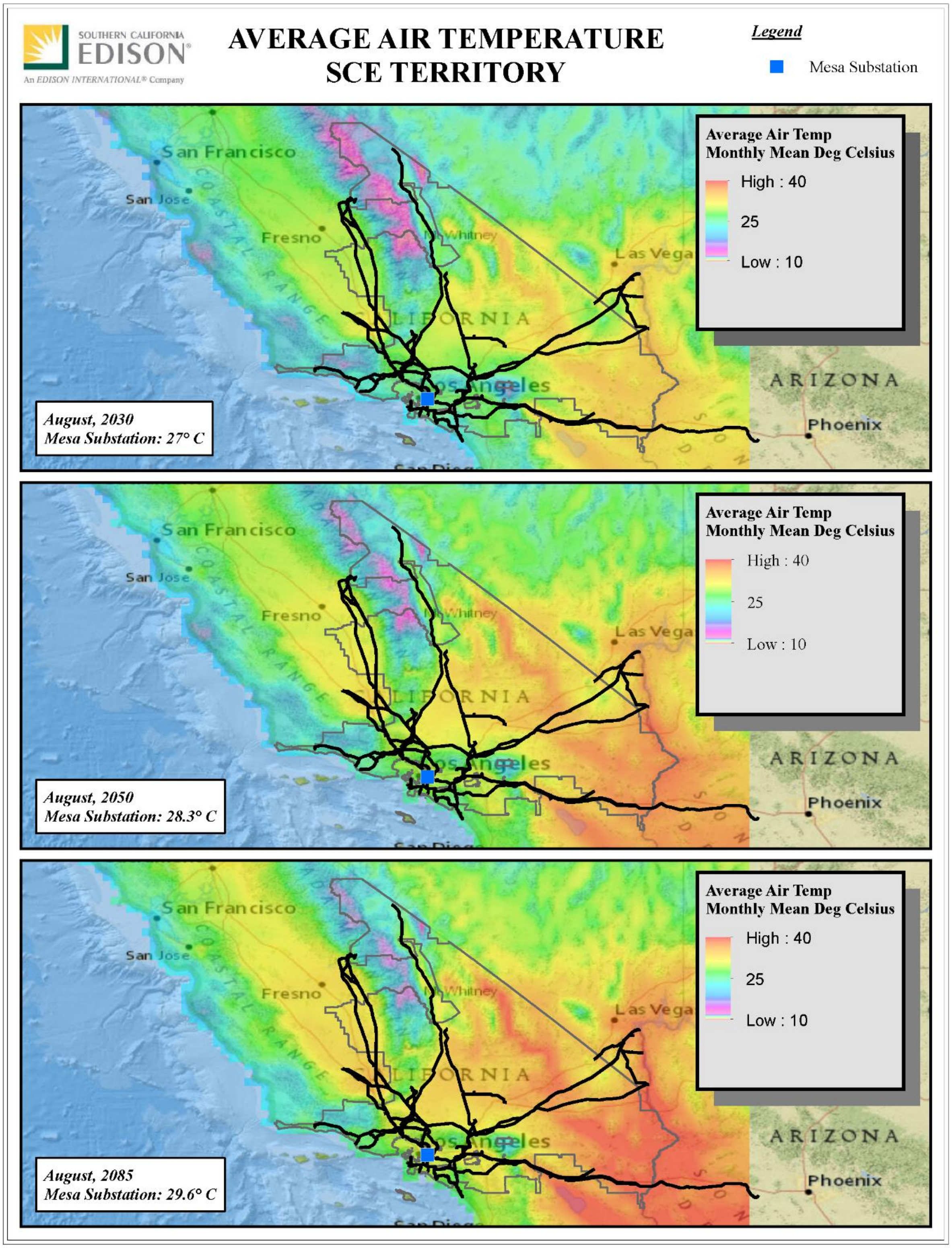
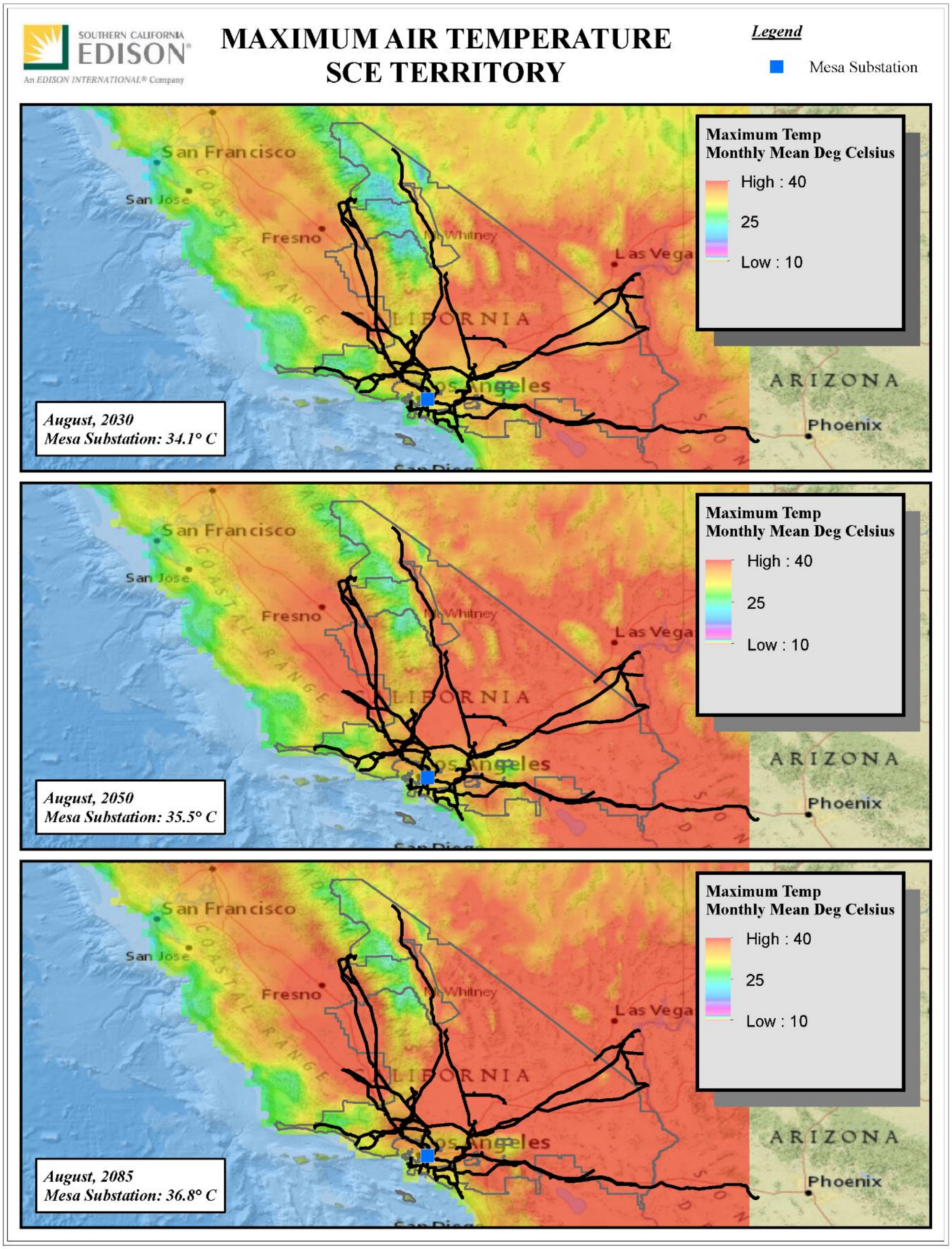
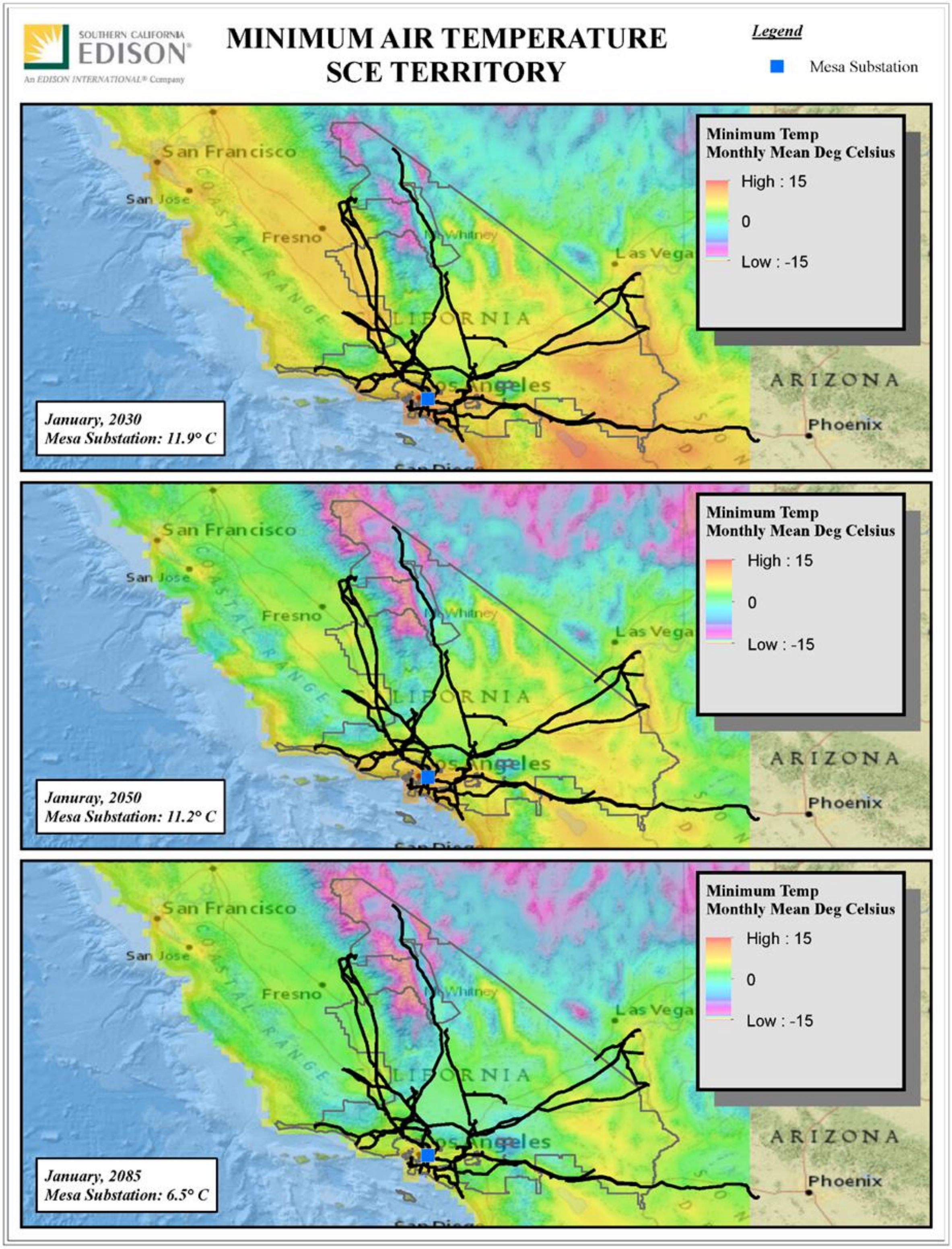
Appendix A. Map of SCE's Service Territory

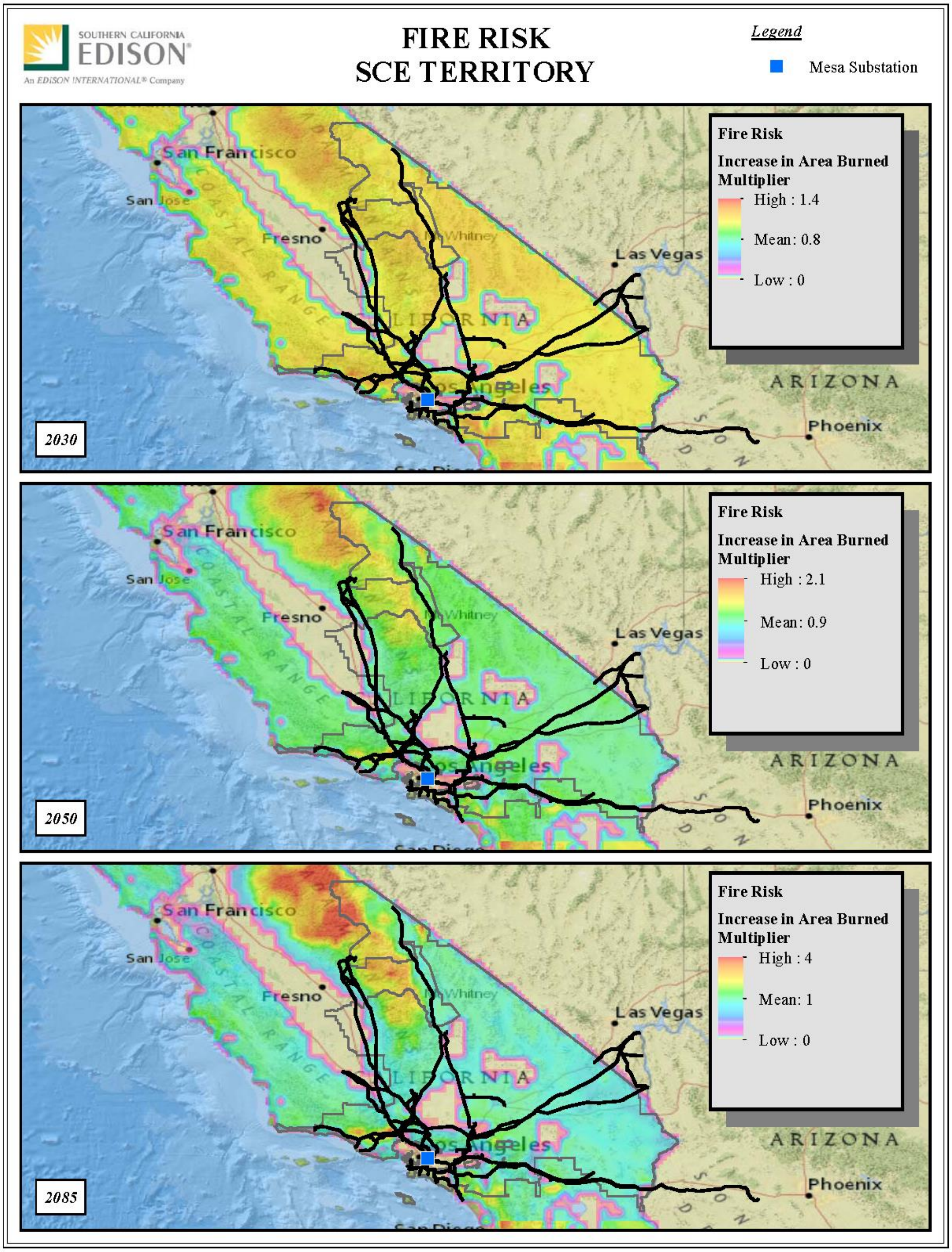


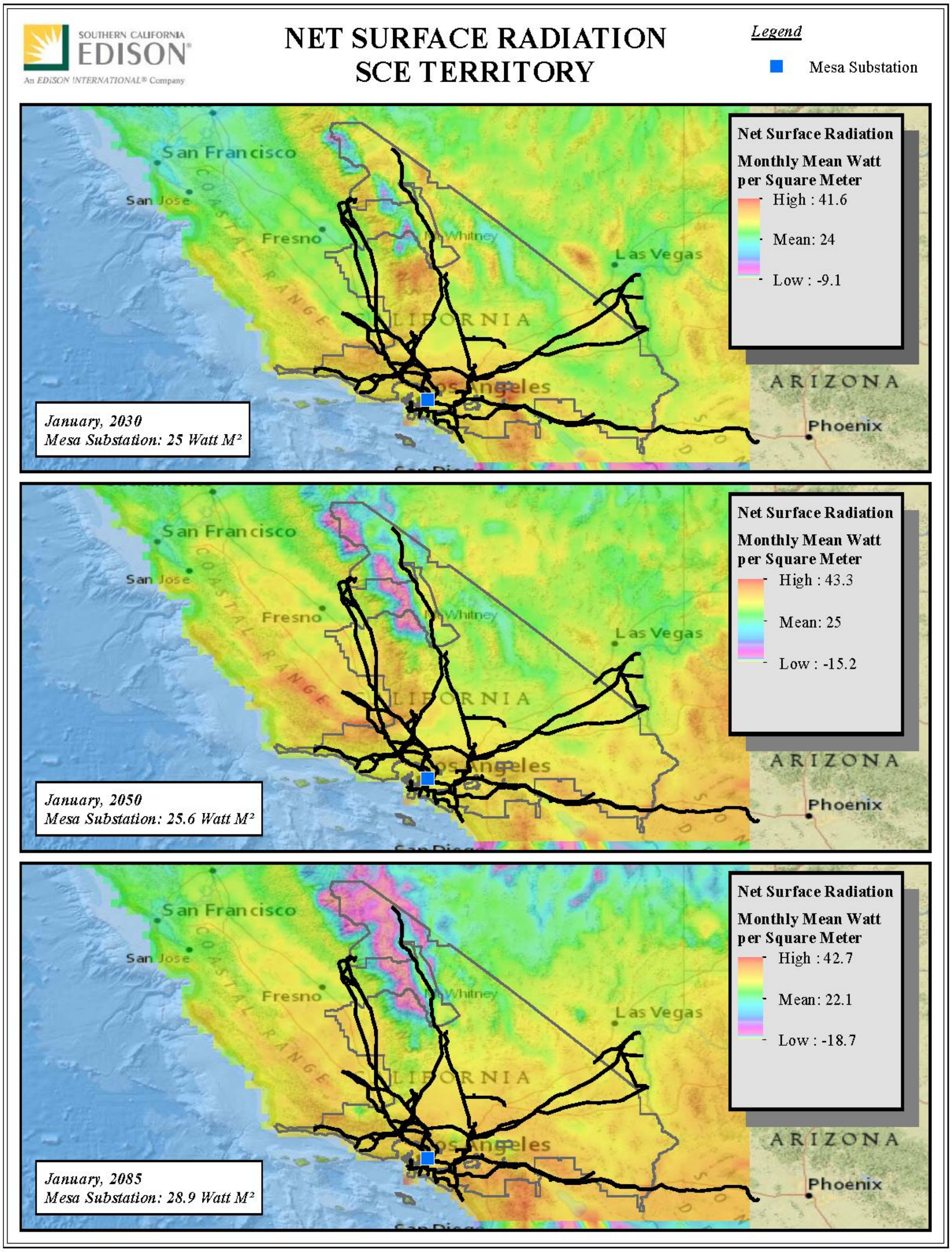
Appendix B: Side-by-side Climate Impact Maps (2030, 2050, 2085)

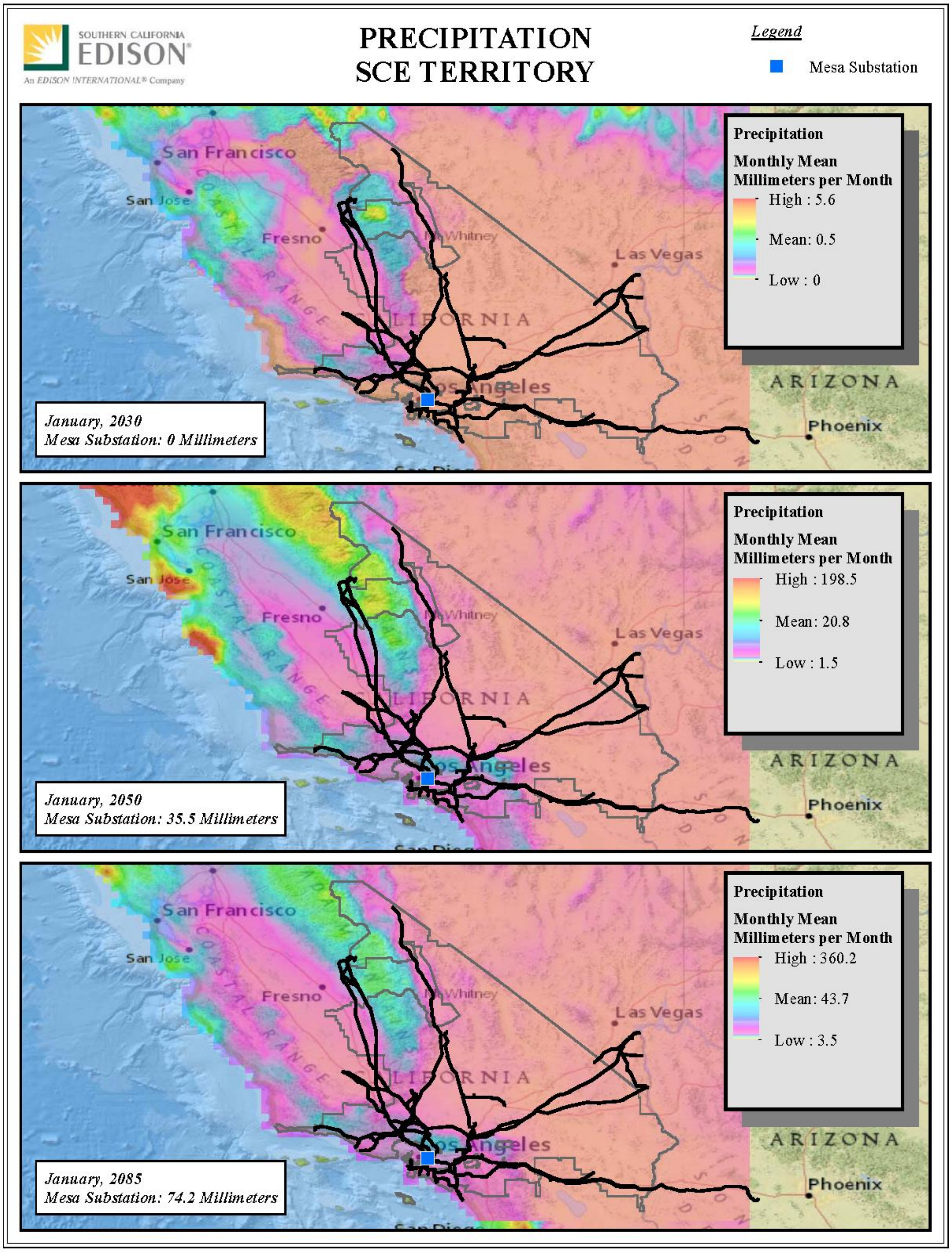


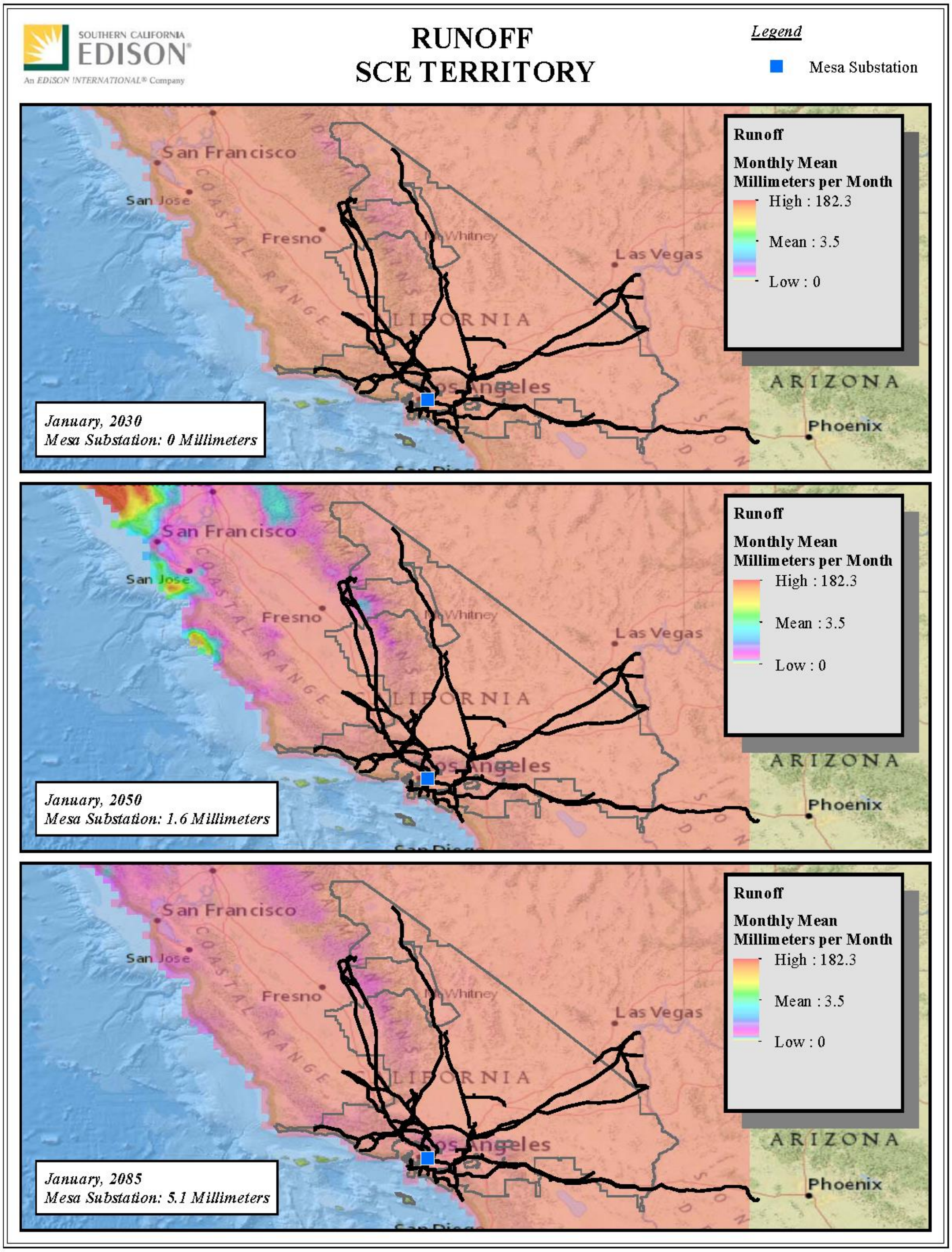

SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL® Company
MAXIMUM AIR TEMPERATURE
SCE TERRITORY
Legend
Mesa Substation
Maximum Temp
Monthly Mean Deg Celsius
High : 40
25
Low : 10
San Francisco
San Jose
Fresno
Las Vega
CALIFORNIA
Los Angeles
ARIZONA
Phoenix
August, 2030
Mesa Substation: 34.1° C
August, 2050
Mesa Substation: 35.5° C
August, 2085
Mesa Substation: 36.8° C

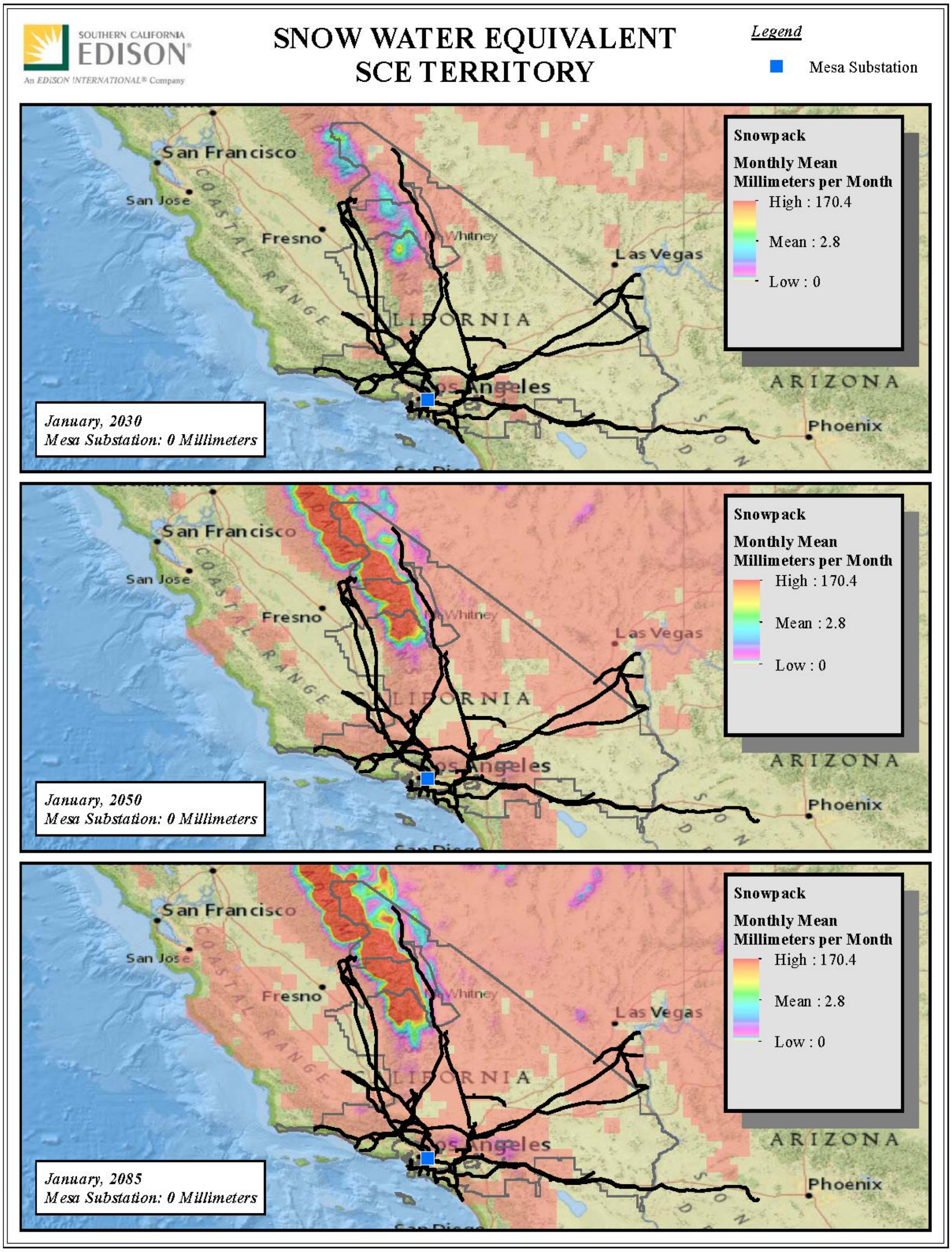

SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL® Company
MINIMUM AIR TEMPERATURE
SCE TERRITORY
Legend
Mesa Substation
Minimum Temp
Monthly Mean Deg Celsius
High : 15
0
Low : -15
San Francisco
San Jose
Fresno
Las Vega
CALIFORNIA
Los Angeles
ARIZONA
Phoenix
January, 2030
Mesa Substation: 11.9° C
Minimum Temp
Monthly Mean Deg Celsius
High : 15
0
Low : -15
Januray, 2050
Mesa Substation: 11.2° C
Minimum Temp
Monthly Mean Deg Celsius
High : 15
0
Low : -15
January, 2085
Mesa Substation: 6.5° C


SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL® Company
FIRE RISK
SCE TERRITORY
Legend
Mesa Substation
Fire Risk
Increase in Area Burned Multiplier
High : 1.4
Mean: 0.8
Low : 0
2030
Fire Risk
Increase in Area Burned Multiplier
High : 2.1
Mean: 0.9
Low : 0
2050
Fire Risk
Increase in Area Burned Multiplier
High : 4
Mean: 1
Low : 0
2085
San Francisco
San Jose
Fresno
Las Vegas
Los Angeles
ARIZONA
Phoenix


SOUTHERN CALIFORNIA
EDISON
An EDISON INTERNATIONAL® Company
NET SURFACE RADIATION
SCE TERRITORY
Legend
Mesa Substation
Net Surface Radiation
Monthly Mean Watt per Square Meter
High : 41.6
Mean: 24
Low : -9.1
January, 2030
Mesa Substation: 25 Watt M²
Net Surface Radiation
Monthly Mean Watt per Square Meter
High : 43.3
Mean: 25
Low : -15.2
January, 2050
Mesa Substation: 25.6 Watt M²
Net Surface Radiation
Monthly Mean Watt per Square Meter
High : 42.7
Mean: 22.1
Low : -18.7
January, 2085
Mesa Substation: 28.9 Watt M²
San Francisco
San Jose
Fresno
Las Vegas
Los Angeles
ARIZONA
Phoenix


SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL® Company
PRECIPITATION
SCE TERRITORY
Legend
Mesa Substation
Precipitation
Monthly Mean
Millimeters per Month
High : 5.6
Mean: 0.5
Low : 0
January, 2030
Mesa Substation: 0 Millimeters
Precipitation
Monthly Mean
Millimeters per Month
High : 198.5
Mean: 20.8
Low : 1.5
January, 2050
Mesa Substation: 35.5 Millimeters
Precipitation
Monthly Mean
Millimeters per Month
High : 360.2
Mean: 43.7
Low : 3.5
January, 2085
Mesa Substation: 74.2 Millimeters
San Francisco
San Jose
Fresno
Las Vegas
Los Angeles
ARIZONA
Phoenix


SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL® Company
RUNOFF
SCE TERRITORY
Legend
Mesa Substation
Runoff
Monthly Mean
Millimeters per Month
High : 182.3
Mean : 3.5
Low : 0
San Francisco
San Jose
Fresno
Las Vegas
CALIFORNIA
Los Angeles
ARIZONA
Phoenix
January, 2030
Mesa Substation: 0 Millimeters
January, 2050
Mesa Substation: 1.6 Millimeters
January, 2085
Mesa Substation: 5.1 Millimeters


SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL® Company
SNOW WATER EQUIVALENT
SCE TERRITORY
Legend
Mesa Substation
San Francisco
San Jose
Fresno
Whitney
Las Vegas
CALIFORNIA
COASTAL RANGE
Los Angeles
ARIZONA
Phoenix
Snowpack
Monthly Mean
Millimeters per Month
High : 170.4
Mean : 2.8
Low : 0
January, 2030
Mesa Substation: 0 Millimeters
January, 2050
Mesa Substation: 0 Millimeters
January, 2085
Mesa Substation: 0 Millimeters